THE ENGINEER

OCTOBER 31, 1952

Zinc and Aluminium Die Casting Productivity Report

ON Monday of this week the report was published of the Zinc and Aluminium Die Casting Productivity Team, which visited the United States during 1951, under the auspices of the Anglo-American Council on Productivity. The team, formed at the request of the Zinc Alloy Die Casters and Light Metal Founders' Associations, visited eighteen plants. The report states that the output of zinc and aluminium pressure die castings per head of population in the United States is two and a half times that of the United Kingdom, while in gravity die casting the output is 70 per cent of that in Great Britain. A comparison between productivity levels was not possible but American production was estimated at 30 to 40 per cent higher for zinc alloy die casting and 20 to 25 per cent higher for aluminium pressure die casting. Regarding gravity die casting different techniques were employed but the team believed that British methods were more advanced. Labour relations, it is stated, appeared good, and the status of the American foreman was particularly noted. and also that the workers realised that profits were essential for a firm to exist and for better wages and conditions to be possible, while agreeing that monetary risk should receive some reward. In America there appeared to be more co-operation between manufacturer and customer and industry was willing to try new methods and take risks commensurate with the rewards of success. Another item noted in the report is the wide use of suggestion and incentive schemes and that neither management nor unions tolerated inefficient workers who were downgraded or discharged. The maximum utilisation of plant and labour was generally aimed at and double day-shift working almost universal. Included in the report are the recommendations put forward by the team, such as : more detailed planning, limitation of the number of designs, a clearer definition of responsibility, a wider use of unit and nest dies, improvement of work flow, greater use of palletisation and mechanical handling, and more employment of semi-automatic die casting machines.

Blending and Bottling Bond

AT South Queensferry, on Friday of last week, Lord Rosebery officially opened the new whisky and bottling warehouse of the Distillers Agency, Ltd., Edinburgh. The buildings, which have been completely designed by the engineering department of the Distillers Company, Ltd., Glasgow, have been constructed on the same site as those destroyed by fire in 1949. At the opening ceremony Sir Henry Ross, the chairman of the company, said that the completion of the building, which had a holding capacity of nearly 1,000,000 gallons, would greatly assist in solving the warehouse storage problem with which the industry is faced. The main building is of reinforced concrete flat slab construction and covers an area of 5000 square yards and has five floors and a flat concrete roof, from which excellent views of the Firth of Forth and of the bridge can be obtained. A dividing wall 14in thick separates the building into eastern and western sections. The latter forms the "In Bond" or "Duty Free" section and is under the control, and conforms with the special requirements, of the Customs and Excise. Here the whisky is blended, bottled and stored, the blending capacity being 30,000 gallons per week, the bottling production rate being 15,000 dozen bottles per week, while the storage capacity is about 800,000 gallons and 30,000 cases. The eastern portion of the building houses the bottle-washing plant, the box-making machinery and serves as a materials store. A rail and road loading dock extends along the north elevation of the main building and on the opposite side is a smaller building of beam and slab and structural steel construction, which houses the cask store, the cooperage and canteen, and takes delivery of whiskies from the various distilleries and from here the whisky is pumped direct to vats in the main building.

Fuel Research, 1951

WITH the publication this week of the Report of the Fuel Research Board and of the Director of Fuel Research for the year 1951, the pre-war practice of presenting reports annually is resumed. The report shows that all the research programmes started or resumed after the war have begun to yield results of value in steadily increasing amount. The work of the Fuel Research Station on the blending of coals for carbonisation to produce metallurgical cokes of acceptable quality has now shown that as much as 30 or 40 per cent of weakly-caking coal may be incorporated in the blends without seriously affecting the quality of the coke. To increase the use of finely-divided, low-grade fuels, experiments on the gasification of small-sized non-caking coal by the fluidised-solids technique have been continued. In the gas-turbine field the use of pulverised coal as a home-produced fuel is an attractive possibility and is being investigated actively. Experimental work has been concentrated on the design of a vortex combustion chamber and on a straight-through combustion chamber working with a Fuel Research Station grid or multijet pulverised fuel burner. Both of these combustion chambers operate without slagging and burn about 500 lb of pulverised fuel per hour at atmospheric pressure. This would correspond, when operating under pressure to fire a gas turbine, to a fuel consumption of about 2000 lb per hour and a power output of 2000 h.p. Efforts have been made to apply the principles of smoke elimination, developed for the Lancashire boiler, to the vertical type of boiler, which is much used in industry, and some improvement in efficiency has so far been achieved. Amongst other items of research work is that on the Fulham-Simon Carves ammonia process for the removal of sulphur compounds from boiler flue gas and the recovery of the sulphur as ammonium sulphate and elemental sulphur, which has received an added incentive, not only from the continued shortage of sulphur, but also from the rise in price of sulphur and its compounds, which has made the process less costly than was at one time thought. Experiments in the small pilot plant which treated 1000 cubic feet of flue gas an hour have been completed satisfactorily. A larger unit to treat 25,000 cubic feet an hour has been built and work with it has been started.

An Award for Training in Industry

IT is announced by the City and Guilds of London Institute that in certain branches of industry additional encouragement and recognition should now be given at a higher level than that represented by its full technological certificates to those engaged in industry who pursue their studies and broaden their knowledge. For this reason the Institute proposes to establish an "Insignia Award in Technology," which will lay emphasis upon technical training based primarily upon practical experience, supplemented by theoretical study, as distinct from the more academic approach to training, for which many educational facilities and inducements already exist. The new award is intended to be a mark of distinction for those who have combined with a sound practical training an adequate knowledge of the fundamental scientific principles of their industry, and who possess a capacity for leadership and administration. A further object of the award is to encourage those who have completed a course of training in some branch of industry to extend their studies to its broader problems, and to widen their knowledge of the scientific principles upon which their industry is based. It is also considered that the introduction of the award will encourage students to take full advantage of the facilities provided in industry and technical colleges, and will lead to the recognition of the value of practical training and experience as basic requirements. It is proposed to introduce the award gradually as opportunity offers in the main branches of the chemical, constructional, electrical, mechanical and textile industries. Particulars of the award scheme can be obtained from the Director, Department of Technology (I.A.), 31, Brechin Place, London, S.W.7.

A Sanitary Engineering Conference

ON Monday last Mr. Harold Macmillan, Minister of Housing and Local Government, delivered an opening address at the first meeting of the third seminar for European sanitary engineers. The seminar will be in progress throughout this week and is being attended by some seventy delegates from twenty different countries. Like its predecessors, which were held at the Hague and in Rome in 1950 and 1951, respectively, it has been organised by the Rockefeller Foundation and the World Health Organisation of the United Nations. The theme of the seminar is the small sewage treatment works, and papers on various aspects of this subject are included in the week's programme, together with several visits and film showings, and a discussion on water pollution research. The seminar has been arranged to take place just before the Public Works and Municipal Services Congress and Exhibition, so that delegates will be able to attend both functions.

The Late Mr. G. N. Guest

WE regret to record the death of Mr. George Nevill Guest, which occurred on October 26th. Mr. Guest was in his seventy-eighth year. He was educated at Burton-on-Trent grammar school, and after an apprenticeship and several years of mechanical engineering experience with various Midland firms, he founded the firm of Hollings and Guest, Ltd., in 1899. He was chairman and managing director of this concern and also of John Hands Power Press Makers, Ltd., until 1932. when the activities of these two firms came to an end. During its life, the firm of Hollings and Guest, Ltd., manufactured hydraulic machinery, such as forging and baling presses, extruding presses, shell presses and so on, and all sizes of accumulators and pumps. From 1932 until his death, Mr. Guest was in charge of the hydraulics department of Tangyes, Ltd. He became an associate member of the Institution of Mechanical Engineers in 1903, and a full member in 1915 ; he was chairman of the Midlands branch of the Institution in 1927. For many years Mr. Guest was the honorary treasurer of the Birmingham Chamber of Commerce.

Bombay Water Supply

(By our Indian Correspondent)

No. I

In India, as elsewhere, there is a tendency for population to flow from rural to urban areas. At Bombay that tendency, combined with the decision that the municipality should be responsible for the supply of all "Greater Bombay," has led to the existing arrangements for water supply becoming inadequate. A new reservoir is being created by damming the Vaitarna River; a tunnel is to connect this reservoir with the existing Tansa Lake, and a new 96in main is to supplement two existing 72in mains. Reasons for the choice of this scheme against alternatives are given and the present state of the works described. The cost will exceed £12,000,000.

BOMBAY, in common with most other cities of India, has been growing very fast during these last ten or twelve years. The census of 1941 gave the city's population as 1·5 million; six years later in 1947 it was estimated at not less than 2·8 million. The flow of population from rural to urban areas has brought tremendous pressure to bear on the existing city amenities like water supply, gas, electricity, &c. Bombay has for some time been feeling the pinch and its water consumption *per capita* per day works out at 40 gallons inclusive of that used for industries, municipal purposes and loss by leakage, against the gross rate of 76·5 gallons enjoyed before the war, in 1939. In the post-war years, the population has not gone down and considering the general trend of flow of population there is no reason to believe that it will do so, at least in the course of the next ten years. Besides, the Bombay Municipality has now brought out its "Greater Bombay Plan," thereby assuming the responsibility of supplying water to outlying districts to which it is proposed to shift the textile and other industries of the city. On the basis of these changes the special engineer put down the immediate and ultimate requirements at 236 and 440 million gallons per day as detailed in Table I. The ultimate requirements of "Greater Bombay" have been assessed at about 380 million gallons per day (m.g.p.d.) on the basis of the total population of 40 lakhs (4 million). This figure includes a reasonable provision for industrial requirements within the Greater Bombay region. It will be seen that the immediate requirements of 236 m.g.p.d. are almost exactly double the present capacity of the system.

TABLE I—*Estimate of Total Immediate and Ultimate Requirements*

Particulars	As in 1945–46	In 1955–56	25 to 50 years hence
Population (million)			
(*a*) City	2·8	2·0	2·0
(*b*) Suburbs	0·4	1·2	2·0
Water requirements (million gallons per day)			
(*a*) City :			
Domestic	59·5	100	140
Industrial	16·5	25	40
Municipal	14·0	20	35
Leakage	23·0	25	45
	113·0	170	260
(*b*) Suburbs (gross)	4·85	42	120
(*c*) Industries at Bhiwandi, Kalyan and Anbernath	—	20	50
(*d*) Towns en route	0·25	4	10
Grand total	118·10	236	440

Bombay receives its supply from three lakes, Tansa, Vihar and Tulsi, the last two being very small reservoirs capable of supplying about 15 m.g.p.d. in good years. Tansa dam, which impounds the reservoir is nearly sixty years old and has been showing signs of age. In years of good rainfall, Tansa is capable of giving a supply of 94 m.g.p.d., but in years of bad rainfall the quantity is considerably reduced. The average reliable supply (with the shutters in) has been worked out at 64 m.g.p.d. after analysing the run-off received in the past fifty years, provided the lakes were drawn upon to this extent only, even in years of good rainfall, and the surplus was carried over to make up the deficit in bad years. The total reliable supply from the existing lakes is therefore 64+15=79 m.g.p.d., and on the basis of figures in Table I additional supply required during the next ten years is 236−79=157 m.g.p.d., ultimate additional supply being 440−79 =361 m.g.p.d.

Tansa is nearly 40 miles away from Bombay (Fig. 1) and two 72in diameter steel pipes and a duct carry the water to the city. The pipes are already twenty years old and are showing signs of deterioration at places. The total carrying capacity of the conduits is only 86 m.g.p.d., which is 8 m.g.p.d. short of the 94 m.g.p.d. which Tansa is capable of giving on an average in good years. After enlargement of outlets, and with shutters in, this capacity of 94 m.g.p.d. may be increased to 110 m.g.p.d., in which case the existing carrying capacity of the conduits would fall short by 24 m.g.p.d. in good years. The problem of augmentation of the city's water supply has thus to be seen in conjunction with both the insufficient capacity of the reservoirs supplying the system and the inadequate carrying capacity of the conduits.

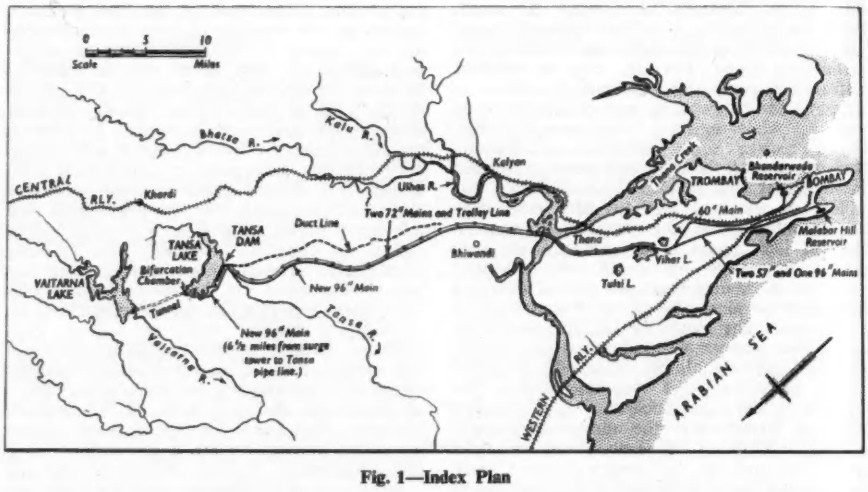


Fig. 1—Index Plan

In an interim report published in February, 1947,[1] the special engineer discussed the various alternatives both on the basis of a report submitted by experts in 1943 and subsequent surveys carried out by the municipality. There seemed to be three main alternatives: (1) raising the Tansa dam or constructing a new higher dam nearby; (2) diverting the waters of a nearby catchment into Tansa Lake; (3) bringing waters from the tailrace of Bhivpuri power station nearly 70 miles away from Bombay.

(1) *Raising Tansa Dam.*—From the analysis of the statistics of the run-off in the Tansa catchment during the last fifty years, it was found that the average figure per year is 50,700 million gallons, which works out at 119 m.g.p.d. after allowing for losses for absorption and evaporation. This is only 25 m.g.p.d. more than the normal 94 m.g.p.d. which Tansa supplies in an average good year. This small additional storage does not appear to justify the cost of nearly £4·5 million for raising the existing dam. Neither is the risk involved in raising the dam negligible. At the time of its construction, no grouting of foundations was done nor did the design allow for buoyancy and consequent upward thrust. In fact, its present condition is causing some concern and a French engineer, Monsieur Coyne, has recently been engaged as an adviser by the municipality.

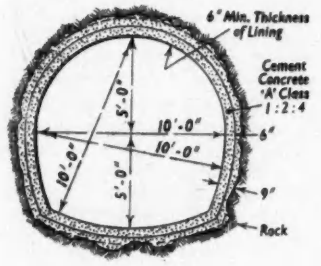
(2) *Diversion of Waters Into Tansa Lake.*—The River Vaitarna has an abundant supply of water which could be impounded and then diverted to Tansa Lake by means of a tunnel about 5 miles long. The water thus stored will help to maintain the new full supply level of Tansa Lake at 422 T.H.D.* (with shutters in) and thereby to obtain a steady supply of 110 m.g.p.d. in all years irrespective of the vagaries of the rainfall in its catchment. Additional storage on the Vaitarna could be made available to the city by direct pipe-line, the size of the storage being decided by economical factors involving the cost of the pipe-line and other ancillary works. The report suggested 72in as the most economical diameter and a storage of 17,000 million gallons as sufficient to keep the pipe-line to its full capacity under the available head. The height of the dam would be 170ft and the capacity of the system would be increased to 175 m.g.p.d. of reliable supply compared with 79 of previous years.

(3) *Bhivpuri Scheme.*—The discharge from the power-house at Bhivpuri not only varies from hour to hour, but from season to season. Bombay gets most of its rain during the monsoon, a period of about three and a half months, and during those crucial months it is necessary to build up the storage of Tansa Lake. The critical factor, therefore, is the amount available from Bhivpuri during the monsoon. The Power Station Company was unable to guarantee more than 37·5 m.g.p.d. during the thirteen weeks of the season, although it could supply up to 100 m.g.p.d. during the remaining period of the year. Moreover, the cost of water thus supplied worked out at 6·6 annas (nearly 7d.) per 1000 gallons of unfiltered water compared with 2·59 for the Vaitarna-cum-Tansa scheme, the figures for filtered water being 7·1 and

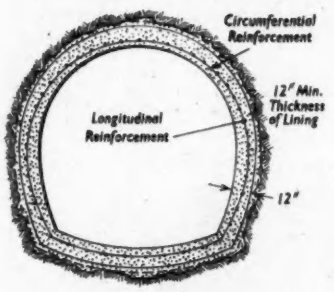
* T.H.D., Town Hall Datum.

4·19 annas respectively. The only other way by which the supply from Bhivpuri could be augmented was by diverting into its catchment waters from the nearby Bhama catchment. This project, which the power company is investigating, is in a preliminary stage, and it is difficult to work out the probable cost without taking into account the general position as regards the water requirements for power generation.

It was obvious from the comparative analysis of the three possible alternatives that only the Vaitarna-cum-Tansa scheme was capable of being exploited expeditiously enough to relieve, within a short period, the immediate scarcity of water. The scheme as recommended by the special engineer involved the construction of a dam 170ft high, a tunnel about 5 miles long connecting the two reservoirs, and a steel pipe-line nearly 40 miles long to the service reservoir at Powai, Bombay. While preliminary details



TUNNEL SECTION IN GOOD ROCK.



TUNNEL SECTION IN POOR ROCK.

Area of Waterway Finished Section 82·64 sq. ft.
Total Length of Tunnel 20,420 ft.

Fig. 2—Cross Sections of Tunnel

were being worked out in the summer of 1947, it became increasingly evident from the rapidly changing political situation in the country that the influx of refugees from the north, a result of the partition of the country, would add considerably to the existing population, thereby upsetting all the plans on which the immediate requirements had been based. By the beginning of 1948 Bombay's population had reached the figure of 3·2 million, almost exactly equal to that assumed for 1955–56, as shown in column 3, Table I. It was thus necessary to revise the original scheme especially in regard to the storage to be provided in view of the fact that the immediate requirements were now in the region of 236 m.g.p.d., including existing supply from the three lakes.

Taking all these considerations in view, a final report was prepared in April, 1948,[2] on which the present scheme has been based. This modified scheme, now being implemented, is described below :

The Reservoir.—The River Vaitarna rises at Trimbak peak (where the mighty Godavary also originates) and cuts its way through the ranges of the Western Ghats to join the Ulhas River. The river gorge is very narrow and has a peculiar shape. The bed width is about 175ft, both the banks being very steep, rising from 310 T.H.D. to 610 T.H.D. in a length of about 1500ft, ending in a plateau at the top at an average altitude of 630 T.H.D. on either side. The catchment area is 174 square miles as compared with 52·5 square miles in the case of Tansa. The average rainfall recorded at Vaitarna is 110in, and on the basis of correlation with Tansa catchment which is similarly situated, it has been estimated that the average annual yield would be in the region of 150,000 million gallons. In the worst year, also on the basis of correlation with Tansa, the yield would amount to about 42,000 million gallons. A detailed survey has shown that "the waters of the Vaitarna reservoir could, at a comparatively small cost, be conveyed to the city independently of the Tansa Lake." It has also been calculated that at the F.S.L. of 535 T.H.D., as decided by the site conditions, the available maximum storage of 54,000 million gallons will be sufficient to (1) maintain the F.S.L. of Tansa Lake at the maximum required level of 422 T.H.D., and (2) supply the city directly with 110 m.g.p.d. The 72in pipe-line from the preliminary design will be substituted by a 96in pipe-line to cater for the increased supply. Due to the steep banks of the river, the water spread of the new reservoir will be about 4·6 square miles against 7·5 square miles of the Tansa Lake. The longest length of the lake is about 10 miles, the loss due to evaporation being assumed at a figure slightly less than 0·02ft per day observed at Tansa. On this basis, the total annual loss has been estimated at 4000 million gallons, which, combined with 8000 million gallons allowed for silting purposes, reduces the maximum available storage to 42,000 gallons of usual storage.

The Tunnel—The tunnel between Vaitarna Lake and Tansa Lake has a maximum capacity of 685 m.g.p.d. at F.S.L. of Vaitarna reservoir standing at 535 T.H.D. It is a "horseshoe" tunnel (Fig. 2) with an equivalent diameter of 10ft, concrete lined and reinforced, depending on the nature of the rock, which has been uncommonly good. It is 20,420ft long, nearly a mile shorter than

TABLE II—*Rough Estimated Cost of the Scheme* (1948)

Job	Cost in Rupees (lakhs)
Survey work	3·37
Preliminary works	37·17
Land	25·00
Dam (including gates)	471·18
Tunnel	209·04
96in pipeline, 46½ miles long	790·81
Offices, stores	10·00
Miscellaneous	52·07
	1598·64, say, Rs.16 crores

Note: Rs. 1 lakh = £7,500
Rs. 1 crore = £750,000
= Rs. 100 lakhs

TABLE III—*Progress Statement of the Works Carried Out by the Contractors*

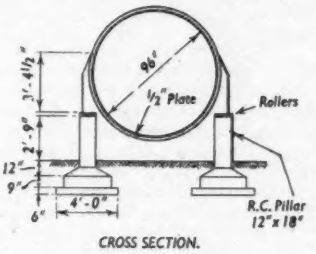
Name of Contractor	Work	Contract amount (lakhs of rupees)	Progress up to March 31, 1952
			Per cent
Hindustan Construction, Ltd.	Tunnel	138·31	78·71
Hindustan Construction, Ltd.	Fabrication, Transporting and laying of 96in steel pipeline for 20 miles only	231·72	1·60
Hindustan Construction, Ltd.	Dam	523·36	7·64
Hindustan Construction, Ltd.	Civil works in connection with pipe-line	76·05	80·00
Mangaldas Verma, Ltd.	Formation for 96in pipe-line (part distance only)	40·59	37·00

Notes: (1) Steel plates for pipeline are being supplied by the municipality ; (2) most of the other work is being done departmentally ; (3) progress percentage represents the ratio of amount allotted to the actual cost.

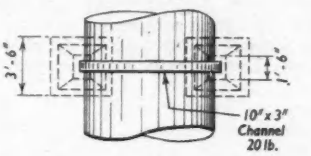
in the preliminary design, and at places where it is overground it is substituted by a 10ft diameter steel pipe.

The Pipeline.—As already stated, the existing pipeline system consists of two 72in steel pipes and a duct which have a total carrying capacity of 86 m.g.p.d. There will be a new 96in diameter pipeline (Fig. 3) running alongside the existing pair and laid directly from the end of the tunnel to Powai—a distance of 46½ miles. The total carrying capacity of the new system will be 210 m.g.p.d., the old pipes carrying 40 m.g.p.d. each, the duct 20 m.g.p.d., and the new pipeline about 110 with the water level in the Vaitarna at its lowest.

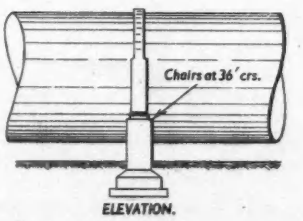
The dam is the chief feature of the scheme and is to be described in detail later in this article. The cost of the works was estimated at Rs. 16 crores (£12 million) in 1948, when the report was first prepared (see Table II). Since then, however, prices have been going up steeply and the ultimate cost may be



CROSS SECTION.



PLAN.



ELEVATION.

Fig. 3—Details of 96in Steel Pipe-Line

much more than allowed for. Contracts for different jobs have been placed and up to March 31, 1952, the work as a whole was in a well-advanced state. This is the first time in India that a job of such magnitude involving a high degree of mechanisation and special technique has been attempted without the help of foreign experts. Table III gives the names of contractors and the progress up to March 31st of the jobs carried out by them.[3]

REFERENCES

1 "Interim Report on Augmentation of Bombay City's Water Supply," February, 1947, by N. V. Modak, Special Engineer, Bombay Municipality.

2 "Final Report on Augmentation of Bombay City's Water Supply," April, 1948, by N. V. Modak, Special Engineer, Bombay Municipality.

3 "Progress Report for Vaitarna-cum-Tansa Scheme for the Period Ending March 31, 1952," published in the proceedings of the Standing Committee of the Municipal Corporation of Greater Bombay, June 18, 1952.

(*To be continued*)

FAMOUS BRITISH TRAINS.—*The Times Weekly Review* has published an interesting sixteen-page booklet entitled *Famous British Trains*, which contains descriptive notes and photographs of some of the famous named express trains running in this country. The trains illustrated are the "Norfolkman," the "Thames-Clyde" express, the "Flying Scotsman," the "Golden Arrow," the "Cornish Riviera," the "Queen of Scots" Pullman, the "Tees-Tyne" Pullman, the "Royal Scot," the "St. Mungo," and the "Torbay Express."

Articulated Locomotives for New South Wales Railways

The first locomotives of an order for fifty 4–8–4+4–8–4 articulated Beyer-Garratt engines have been dispatched to the New South Wales Railways by Beyer Peacock and Co., Ltd. These locomotives, which each weigh some 255 tons and are just under 109ft long, are considered to rank as the most powerful engines built in Europe. They embody the latest developments and improvements and represent a definite advance in the detail and general design of articulated locomotives.

AS part of an extensive locomotive renewal programme, the N.S.W. Railways some time ago placed an order for fifty 4–8–4+4–8–4 Beyer-Garratt locomotives with Beyer Peacock and Co., Ltd., of Manchester, and delivery of the first batch of engines to this order began recently. These new locomotives, each weighing some 255 tons in working order and having an overall length of nearly 109ft, are considered to be among the largest and most powerful engines built in Europe. They are designed for a coupled axle loading of 16 tons, and to negotiate a six-chain curve with ⅜in widening on sidings and in yards. The loading gauge permits a 14ft height and 9ft 8in width, and with their relatively low axle loading the locomotives will be capable of running over most of the lines of the New South Wales system. Their design incorporates a number of interesting developments which are in keeping with the latest practice, and which are particularly directed towards minimising running shed maintenance between general repairs.

We are able to reproduce a number of photographs of one of the new locomotives, together with a weight diagram. The leading particulars are given in an accompanying table.

The boiler is shown in one of the photographs and in the drawing reproduced on page 573. In its construction the fullest possible advantage has been taken of the Garratt articulated design, which enables a firebox of the maximum dimensions to be incorporated with a large diameter barrel. The firebox is of the round top design, and has an inner firebox of Colville's firebox quality steel which is of riveted construction throughout.

All the tubes, of solid-drawn steel, are fitted with copper ferrules at the firebox tubeplate end, where they are prossered and beaded over. The flue tubes are rolled and beaded over at the smokebox tubeplate and the small tubes rolled over with the exception of sixty, which are both rolled and beaded.

The foundation ring is of fabricated mild steel, and machined on the surfaces in contact with the firebox plates. The water space stays are of Longstrand steel and flexible stays are arranged in the breaking zone. Flexible roof stays are fitted at the front of the firebox, the simple shape of the box lending itself to efficient staying arrangements with the minimum of obstruction to waterways.

The first twenty-five locomotives are being built with five steel arch tubes, 3in diameter, in the firebox, but the second twenty-five will have two thermic syphons. The superheater has fifty elements, providing 750 square feet of superheating surface. It is built with solid-drawn steel tubes with integrally forged return bends and ball joints. The multiple-valve regulator incorporates recent detail improvements and has the valves on the saturated side.

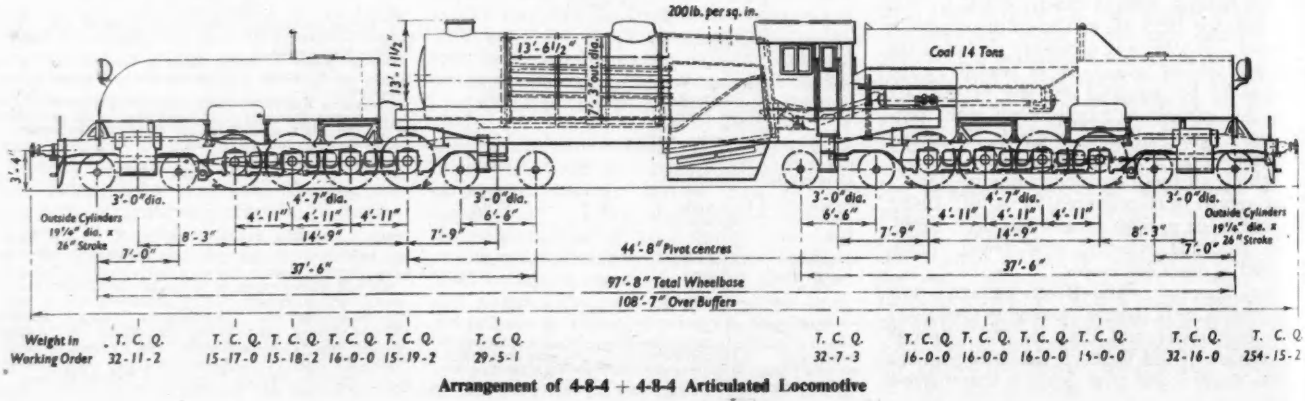
A "Melesco" steam dryer is fitted in the boiler dome, and a separate drifting valve has been incorporated in the header in accordance with New South Wales practice. All this equipment is supplied by the Superheater Company, Ltd. An adequate and accessible arrangement has been made of washout plugs and doors, all of which, including the fusible plugs, are to the New South Wales Railways standard. Two "Everlasting" blow-down valves are arranged on the throat plate and the boiler has a continuous blow-down valve located on the firebox back, together with a water sampling valve.

The boiler is fed by two Davies and Metcalfe "1918B" live steam injectors operated by quick-

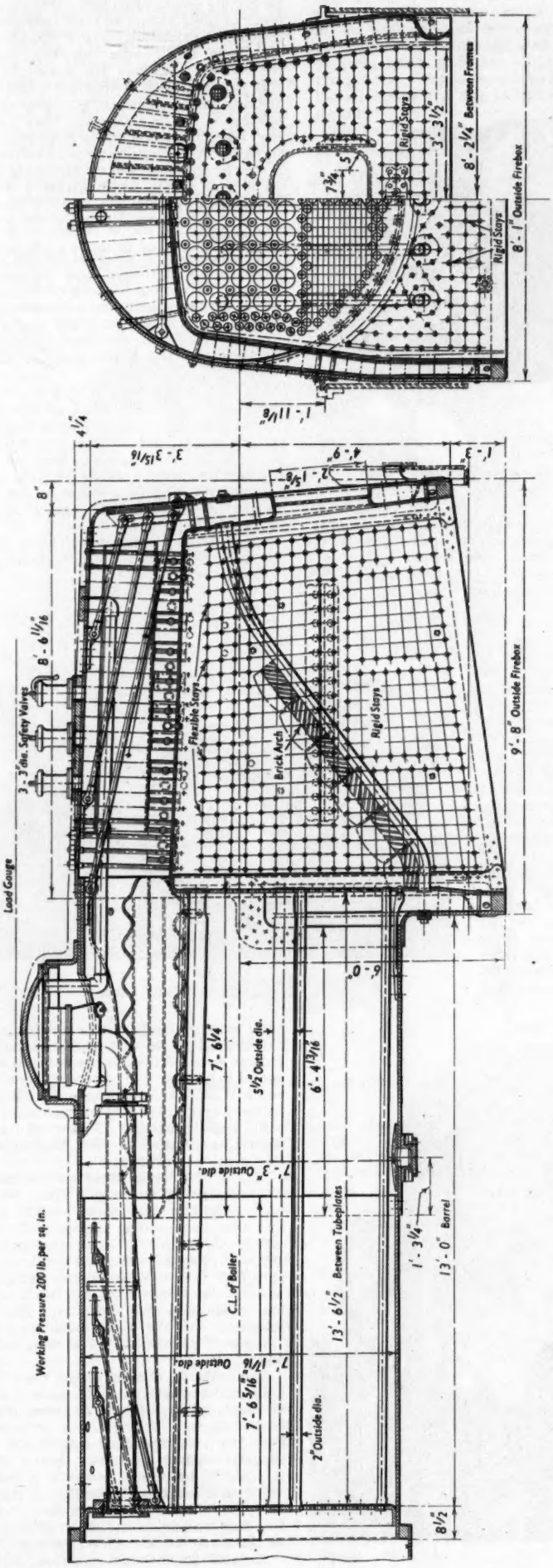
Leading Particulars

Cylinders (4), dia. by stroke	19½in by 26in
Coupled wheel, dia.	4ft 7in
Bogie wheel, dia.	3ft 0in
Wheelbase, each unit	37ft 6in
Wheelbase, rigid	14ft 9in
Wheelbase, total	97ft 8in
Length over buffers	108ft 7in
Height (rail to top of chimney)	13ft 11½in
Width over cab	9ft 7in
Axle load	16 tons
Adhesive weight	128 tons
Coal capacity	14 tons
Water capacity	9200 gallons
Total weight (in working order)	255 tons
Tractive effort at 85 per cent B.P.	59,560 lb.
Tractive effort at 75 per cent B.P.	52,550 lb.
Boiler pressure	200lb per square inch
Boiler barrel, dia.	7ft 3in
Length between tubeplates	13ft 6½in
Heating surface :	
Tubes : 50 flue, 5¼in o.d.; 258 small, 2in o.d.	2799 square feet
Firebox (including arch tubes)	242 square feet
Total evaporative	3041 square feet
Superheater : 1¼in o.d. tubes	748 square feet
	3789 square feet
Grate Area	63·4 square feet

Articulated Locomotive for New South Wales Railways



Arrangement of 4-8-4 + 4-8-4 Articulated Locomotive



Boiler of Articulated Locomotive

acting injector steam valves on the firebox side. Water is delivered through clack boxes positioned on the top of the front course of the boiler. The main steam turret is mounted on top of the firebox outside the cab front plate and all valves are conveniently arranged for remote control from the cab. All the work on the boiler and the tests carried out on it at the maker's works are in accordance with the requirements of the Australian Boiler Code, but all materials conform to British Standard Specification.

The self-cleaning smokebox is of straightforward design and arrangement. A cast iron blast pipe is fitted with blower ring. The wrapper plate is in one piece and the smokebox tubeplate is of drumhead design, the whole being supported on the boiler frame by cast steel supports on each side. The main steam pipes are solid-drawn steel with cast steel pipe elbows.

The firegrate is arranged for hand rocking in four sections by means of a single control lever and special gear is provided in the cab for alternative interlocking so that individual sections of the grate can be rocked, or rocking can be to a wide angle for dropping the fire. The grate is designed for coal having an ash content up to 20 per cent, and a calorific value varying from 10,500 to 12,000 B.Th.U.s.

The fullest possible use is made of the unobstructed space available to have a large self-cleaning hopper ashpan with side air doors, operated by levers from the cab. The bottom-emptying doors which discharge between the rails are hand-operated. An "Everlasting" blow-off cock, arranged under the platform, serves as an ashpan drench.

With a grate area of 63·4 square feet and the need to burn efficiently coal of varying and inferior quality, it is natural that a mechanical stoker should be fitted and an "HT" stoker, with 5in by 5in engine, has been conveniently arranged in an accessible position on top of the hind pivot casting. All the stoker controls are conveniently arranged in the cab on the fireman's side with, in addition to the engine throttle valve, an engine booster valve which gives quick action for emergency use.

The five jet valves of this stoker provide means for the careful control of the firing from the table plate, and a reversing valve under the platform is easily operated for quick reverse of the conveyor screw when this is necessary. A mechanical lubricator provides lubrication for the stoker engine cylinders, its crankshaft and associated parts being lubricated on the splash system from the engine sumps.

The following boiler ratios are given as a matter of interest :—

$$\frac{\text{Evaporative heating surface}}{\text{Grate area}} = 47{\cdot}96.$$

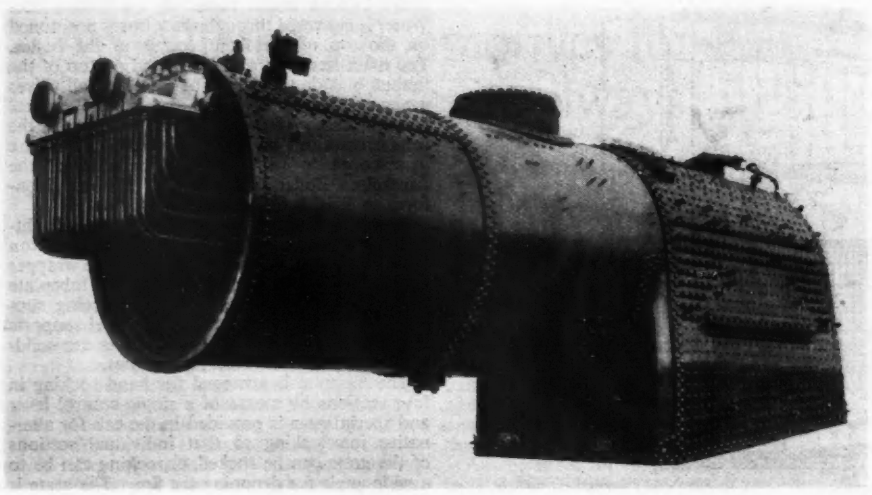
$$\frac{\text{Evaporative heating surface}}{\text{Superheater heating surface}} = 4{\cdot}07.$$

$$\frac{\text{Free gas area}}{\text{Grate area}} = 14{\cdot}6.$$

When the locomotives were ordered it was specified that, if possible, cast steel beds, as manufactured by the General Steel Castings Corporation, of America, for other locomotives in service in New South Wales, should be incorporated in the new engine frame units. These cast steel beds were used and they are made integral with the cylinders and valve chests—as well as some of the stays and brackets ; other brackets, cast separately, are welded on to the main structure. Each of the cast steel frame beds weighs some 13 tons. The buffer beams are separate steel castings.

The steel plate boiler unit frames have carefully designed frame stretchers and stays to ensure the maximum possible rigidity and strength. A cast steel frame stretcher at each end of the boiler unit incorporates a self-adjusting pivot centre fitted with spring-loaded side bearers. These centres, in addition to being lubricated from the main mechanical lubricators, have an auxiliary oil syphon feed to the top face.

Renewable cast iron liners with an inside diameter of 19¼in are fitted in the cylinders and provision is made for boring the liners to 20¼in at some future date. The steel centres of the pistons have renewable cast iron bull rings riveted on to them, and the cylinder covers are



Boiler and Superheater of Articulated Locomotive

made with breaking grooves in accordance with the railway company's practice. The 10in diameter piston valves have three rings on each head and are trick ported, the trunk way between making steam connection between the trick ports which are arranged between the first and second rings on the heads. Automatic water pressure release valves are fitted on the sides of the tanks and connected by pipes to isolated valves on the cylinder covers. The cylinder and steam chest drain valves are operated by a small compressed air-operated cylinder set on each of the main cylinders. The cylinder cocks are shrouded by a metal box.

The motion, which can be clearly seen in one of the photographs we reproduce, has a straightforward arrangement of Walschaerts valve gear, and the die blocks are in the lower or direct half of the link on both units when running chimney first. In full gear, the valve travel is 6½in. With the latest design of Hadfield power reverse gear which is fitted, easy operation is ensured. The operating cylinders for this gear are conveniently arranged on the side of the boiler frame and straight line operation is given to the main reversing rod. The gear gives a positive and accurate selection of cut-off with a complete absence of creep.

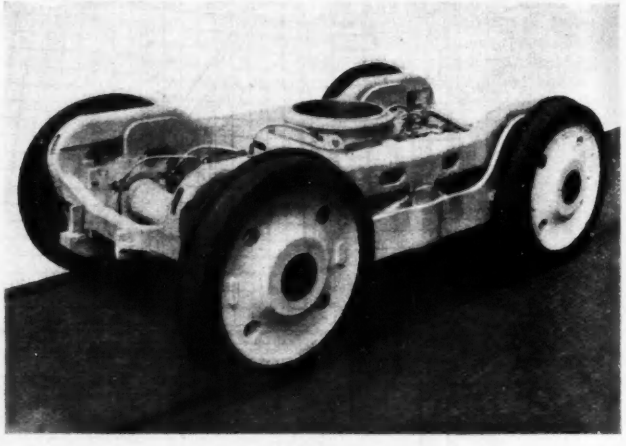
Laird design crossheads made of cast steel are fitted with cast steel slippers lined with white metal. The slide bars, spindle guides, reversing link trunnions and reversing shafts all have mechanical lubrication, but an "Ajax" soft grease system lubricates the remainder of the motion.

The connecting and coupling rods are of forged steel, and roller bearings are fitted on the driving crank pin. The intermediate crank pin has a renewable bronze floating bush in the eye of the coupling rod working in a hardened-steel fixed bush. This arrangement enables replacement of the floating bush to be made without dropping the rods and the consequent disturbance of the roller bearing assembly on the driving pin. The small end of the connecting-rod is fitted with a pressed-in bronze bush, whilst the large end of the rod and the driving crank pin bearing of the coupling rod are fitted with "Skefko" self-aligning roller bearings mounted on tapered sleeves. These roller bearings and the other coupling rod bushes fitted with lead bronze fixed bushes are grease lubricated. The coupled axle horn channel liners and the wedges for the coupled axleboxes are made of phosphor bronze, and have steel wedge adjusting bolts. All the coupled axleboxes are made of cast steel and are fitted with double-row "Skefko" self-aligning roller bearings arranged for grease lubrication. The axleboxes have manganese steel renewable liners on the horn guide wearing surfaces. An interesting point about the bearings is their arrangement and the method of mounting on tapered sleeves which makes it possible to withdraw a bearing and move it towards the centre of the axle to expose the axle journal for examination.

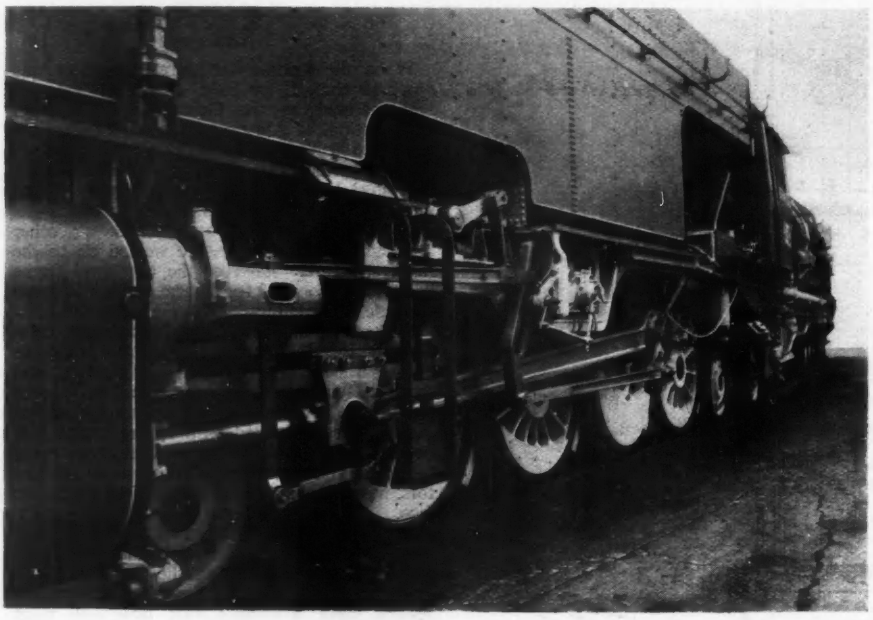
All axleboxes are designed for use with overhung laminated springs, and compensation is arranged throughout the coupled wheels on each side of the engine units, but independent from the bogies. All spring gear details and also those for the brake gear are fitted with "Walter" hardened-steel split bushes provided with grease lubrication.

All the wheels have flanged tyres and are dynamically balanced. They all have cast steel centres with solid balance weights except for the driving wheels, which have pockets to enable adjustments to be made by lead filling. The coupled wheels have shrunk-on tyres, which are secured by rivets to conform to the railway's standard practice, and the bogie wheel tyres are secured by Gibson rings.

The expansion joints and ball joints throughout the engine are made in accordance with the latest practice, and particular care has been given to make all such joints readily accessible from ground level. Provision has been made at each end of the locomotive to accommodate the New South Wales Railways' standard buffer unit with friction draft gear and an automatic coupler with screw coupling. These units are to be supplied and fitted to the locomotives when they arrive in Australia.



Bogie with Cast Steel Frame



Motion of Locomotive Hind Unit

One of the bogies fitted to the locomotives is illustrated on this page. These bogies have box-section cast steel frames made in one piece, and they have sliding centres with laminated spring side control. The frame castings were specially designed and made by Beyer Peacock and Co., Ltd. Their centres have "Ferrobestos" liners protected by felt dust shields, and manganese steel liners are fitted to the pedestals. All the bogie axles are fitted with "Skefko" double-row self-aligning roller bearings.

The brake for the engine and train is a Westinghouse Australian A6–ET pattern, acting on all coupled wheels of the engine through equalised brake rigging. Air pressure is provided by 8½in 150 cross-compound compressor, which is manufactured in Australia. Brake application is made by the use of an A6–P pedestal brake valve, and the usual controls are conveniently located in the cab. The compressor has its own four-feed mechanical lubricator, which is mounted on the smokebox near the compressor.

A hand screw brake operates on the hind locomotive unit only through hand gearing

fixed on the cab back plate. The whole system provides for straight air-braking on the engine in addition to automatic braking for engine and train. The appearance of the locomotive has been improved by the careful shaping of the tanks and bunker, the lines of which are designed to give a clear view in both directions from the cab, and also add to the general appearance. A common cause of maintenance has been overcome by the use of the maker's special method of fastening the tanks to the frame. Under this arrangement special shoes locate the tanks longitudinally and transversely, and the holding-down bolts are spring-loaded.

This arrangement allows occasional slight deflections of the frame to occur without causing undue stress in the tank structure when traversing uneven track. The tanks and bunker are of riveted construction with the usual fittings, which include fill holes at both ends of the locomotive and a tank water-level gauge. Particular attention has been given to the shape and design of the bottom of the coal bunker to ensure the efficient fall of fuel into the conveyor of the mechanical stoker.

In arranging a comprehensive lubrication system for the locomotive, every effort has been made to provide an accessible and reliable system to reduce to a minimum the attention and preparation time required of the engine crew. Each locomotive unit carries four mechanical lubricators—made by the Nathan Manufacturing Company, and also by Davies and Metcalfe, Ltd. Two of these lubricators feed oil to the axlebox guides, slide bars, valve spindle guides, reversing link trunnions, reversing shafts and pivot centres. The other two lubricators feed oil to the steam chests, piston valve liners, cylinder barrels, steam and exhaust ball joints and the stoker ball and telescopic joints.

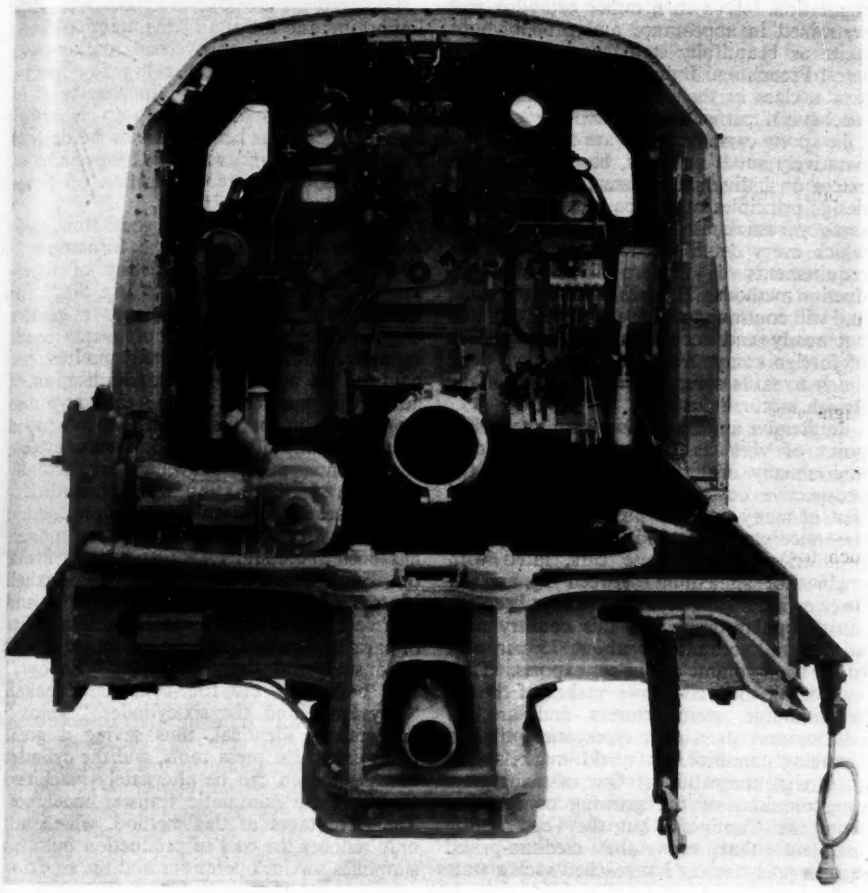
The particularly roomy cab of the locomotive has all the controls arranged to afford the crew the maximum comfort and ease commensurate with efficient operation. It has a double roof fitted with an inner lining of wood and, with the large air doors in this roof and in the front plate, adequate means are provided for cooling the cab in hot weather. The driver and fireman have upholstered seats fitted with back and arm rests, provision being made for adjusting seat height and position. A photograph on this page shows the arrangement of the fittings and controls in the cab.

The water gauges conform to the railway company's standard, the one on the left hand being mounted on a special column which is also fitted with three test cocks.

The drifting gauge and steam pressure gauge are well placed in full view of the driver; and the reversing gear, regulator and brake handles are close to his hand, whilst leaving him in free position to look forward.

The cab fittings and controls for the mechanical stoker are in accordance with the Standard Stoker Company's latest design. On each side below the fire-hole door are levers which can be used to control the coal outlet on to the table plate. The boiler is fitted with three 3in Ross pop safety valves, and has a steam chime whistle operated by cable from the cab. The eight sand boxes fitted are arranged to deliver sand in front and behind each group of coupled wheels. These boxes have pneumatically-operated sand traps and valves supplied by Gresham and Craven, Ltd. Each engine is provided with four 35-ton screw jacks and two re-railing ramps. The engines are fitted with Stone's electric lighting equipment, current being generated by two 32V turbo-generators for two 500W "Tonum E" headlights, and the usual cab lights. Additional points are provided for the illumination of the motion, lubricators, injector overflow and tank filling holes.

The locomotives, designated class "AD–60" are numbered from 6001 onwards, and each will be finished painted on arrival in New South Wales with black underframes and smokebox; the boiler and tanks being finished in black with a narrow red lining and red buffer beams.



Arrangement of Controls and Fittings in Cab

Sugar Beet Harvesting Machinery Demonstration

THE seventh annual demonstration of sugar beet harvesting machinery, organised jointly by the British Sugar Corporation, Ltd. and the National Agricultural Advisory Service, was held on Thursday and Friday of last week, October 23rd and 24th. The policy of the organisers is to select a different beet growing area for these demonstrations each year, and this year the site made available was an extensive one on the farm of G. P. Harding and Son, at Chrishall Grange, on the Cambridgeshire-Essex border. The machines seen at work emphasised the progress that is being made by agricultural engineers in the mechanical harvesting of one of this country's most important root crops.

About 400,000 acres of land in Great Britain are now given up each year to the growing of sugar beet, and last year the quantity of beet produced amounted to 4,533,512 tons, which in its turn yielded 601,455 tons of white sugar. This was the second highest output to be achieved in the history of the industry in this country. This year's crop, occupying much the same acreage as last year, is described as a good average one. The harvesting of it is now in full swing in the various beet-growing areas throughout the country, the beet being taken for processing to the eighteen sugar factories operated by the British Sugar Corporation.

Last year, approximately 20 per cent of the sugar beet crop was harvested mechanically, and the indications are that in the present season that figure will increase to 25 per cent. That may seem still to be a small percentage when compared with the mechanised harvesting of many other crops in this country. But when it is remembered that five years ago only 1·4 per cent of the sugar beet crop was harvested mechanically, a better idea is gained of the progress made in the design, development and reliability of machines which will top, lift and deliver the beet either into accompanying trailers or on to the ground to be collected subsequently. When the first harvester demonstration was held in 1946, nine machines were shown, and soon after the start it was necessary to announce that "all the machines have, for the time being, ceased to operate; repairs are being carried out as quickly as possible."

In last week's demonstration, twenty-six different machines were at work. Some of them were machines capable of carrying out the complete harvesting operation, i.e. topping, lifting and conveying, while some were machines designed to perform one or other of those functions. Of the harvesters taking part in the demonstration, nineteen are now in production, and seven are still in the prototype or development stages. In the production class, twelve of the machines were of British origin and seven of foreign design, while in the prototype class there were two British and five foreign machines. The majority of the machines are driven by the power take-off from a tractor, though there was one machine—a complete harvester of foreign design—which was "self-propelled."

In recent years, increasing attention has been given to the value of the beet tops, in addition to the value of the sugar content of the root. The tops are used principally for cattle food, and top-saving equipment is now, therefore, an important part of beet harvesting machinery. This aspect was emphasised by the demonstration which also included equipment required for ensiling the beet tops and crowns. Yet another important section of the demonstration was that in which several mechanical loaders and conveying attachments to tractors were to be seen at work. In addition to the machinery at work, there was a static exhibition which attracted considerable interest. It included duplicate models of several of the harvesters operating in the field demonstration.

The demonstration was certainly an international event, the visitors including farmers and agricultural engineers from eleven overseas countries, as well as many from all parts of the United Kingdom. The overseas visitors, together with a company of British guests, were entertained at dinner in Cambridge on Thursday of last week, by the British Sugar Corporation.

The International Motor Show

No. I

THE International Motor Show, which opened on Wednesday, October 22nd, and will close to-morrow, November 1st, is the thirty-seventh of its kind to be arranged by the Society of Motor Manufacturers and Traders. This year's show coincides with the golden jubilee of the S.M.M.T., and the organisers have made every effort to make it even more impressive than before.

Once again at Earls Court the latest products from the motor industries of six countries are on view in what is acknowledged to be the greatest motor exhibition in the world. Of the sixty-three motor manufacturers showing their latest products, thirty-two are British with a total of 197 exhibited cars ; the remaining thirty-one firms are from overseas with a display of ninety cars from U.S.A., Canada, France, Italy and, for the first time, from Spain.

Apart from production models, however, at this year's show the Society has allowed, for the first time, British manufacturers of specialised cars the opportunity of displaying cars which have given outstanding performances in racing events in this country over the first half of this year. They include, in Formula 2, the racing cars of Alta, Connaught, Cooper-Bristol, Frazer-Nash and H.W.M., and the Formula 3 cars of Kieft and Cooper. The only Formula 1 car in production in Britain during the past twelve months, the B.R.M., is not included in this special display, though as an example of bold and unorthodox automobile design it would certainly have provided considerable academic interest.

In addition to these racing cars, several sports cars which have enhanced British prestige are being shown. Among them is the 3·5-litre Jaguar " XK 120," a fixed-head coupe, which last August, at Montlhery, exceeded 100 m.p.h. during a continuous seven-day run, thereby establishing four world and five international Class " C " records, and further, the M.G. record-breaking car, which also last August, at Utah, U.S.A., improved the previous Class " F " international world record over 5 miles from 139·2 to 189·5 m.p.h., and holds approximately 100 world and national records. Other cars include the 2·6-litre Aston-Martin of Le Mans and Mille Miglia fame, and one of the three Sunbeam-Talbot " 90 " saloons which gained the Coupe des Alpes, the highest individual award in the 1952 Rallye Internationale des Alpes. The interest of the public in this special display is pronounced and it is to be hoped that the S.M.M.T. will continue this practice of allowing exhibitors to show used cars which have distinguished themselves in international sporting events.

These cars may not play a very important part in the total volume of our exports, but they have helped to enhance Britain's reputation for good engineering. Built in comparatively small numbers, their design is more flexible than that of cars made by large-scale production methods, and the necessity of competing in international sporting events has caused their designers to consider all known means and ways of improving the overall efficiency. Nearly all the sports cars at the exhibition, to name only a few of them like Lagonda, Lea-Francis, Frazer-Nash and Bristol, are first-class examples of advanced automobile design, and there is little doubt that some of the principles embodied in their construction — high-performance engines, independent rear wheel suspensions and powerful fade-resisting brakes—will eventually gain wider application in ordinary production models.

As usual, the Motor Show is well stocked with luxury cars like Rolls-Royce, Bentley, Daimler and other cars, which, by virtue of their fine workmanship, their exceptional reliability, responsiveness, silence and longevity, enjoy a widespread international reputation. As a rule, rather orthodox and restrained in appearance and probably not quite as beautifully styled as some of the latest French and Italian models, they represent a class of their own, a class in which mechanical perfection is taken for granted. Like sports cars, they also are made in comparatively small numbers, based to a great extent on individual craftsmanship, and their design principles cannot be assessed with the same yardstick as that applied to cars in which every detail has to comply with the requirements of modern large-scale production methods. These cars have always had and will continue to have a somewhat limited but ready and secure market, irrespective of foreign competition, and they have done much towards spreading the prestige of the British motor industry.

Impressive and interesting from a technical point of view as sports and luxury cars undoubtedly are, the main interest of the prospective customer in this country and that of many overseas buyers centres round the medium-sized and moderately-priced production cars. These cars, fitted with engines of something between 1½ and 2½ litres cylinder capacity, have always been the most popular designs in this country and, at present, account for about 75 per cent of the total volume of our car exports. They include all the well-known makes of the six large motor manufacturers and are, of course, more than other types, susceptible to changing conditions in world markets and to foreign competition. Our manufacturers are conscious of the growing competition from the Continent, but they can rightly maintain that even the medium-priced British post-war car has reached such a state of general perfection that it is now acceptable in other countries whatever the operating conditions. Furthermore, the immediate post-war years, which gave the industry a considerable amount of protection from foreign competition, have enabled manufacturers to base their trade on a network of overseas sales and service organisations, far more extensive than that of any other European motor-producing country. In these circumstances, there is sufficient room for a qualified optimism ; although it seems certain that the days of the seller's market are over, the industry is confident that markets will be maintained providing the supply of essential raw materials, especially steel, is sufficient to hold at least the present volume of production.

In a buyer's market, first cost is always important, and the aim of maintaining hard-gained advantages on overseas markets will depend, first of all, on checking any further rise of production costs. Improvements in production methods will help to a certain extent, but greater benefits are to be derived from stricter standardisation, especially of accessories, and by concentration on fewer models from any one factory.

As far as standardisation goes, some progress has been made by the formation in 1948 of a committee consisting of representatives of the so-called " Big Six," for the purpose of working towards a greater degree of uniformity of components made by outside firms. So far, the committee has confined its work to the standardisation of accessories purchased by the six companies from common sources, but it is to be hoped that eventually other parts or even complete components, many of which are actually suited for standardisation, will be included.

The question of simplifying the production process by concentration on fewer models has been successfully tackled by two firms, the Ford Motor Company and Vauxhall Motors, Ltd. The Ford " Anglia " and " Prefect " have a very considerable number of parts in common, as have the four-cylinder " Consul " and the six-cylinder " Zephyr." The bodies of the four-cylinder Vauxhall " Wyvern " and the six-cylinder " Velox " are entirely identical, thus saving a great many expensive press tools, and the cylinder blocks of each can be alternately machined on the same automatic transfer machines. The advantages of this method, which not only reduces the cost of production but also simplifies service operations and the stocking

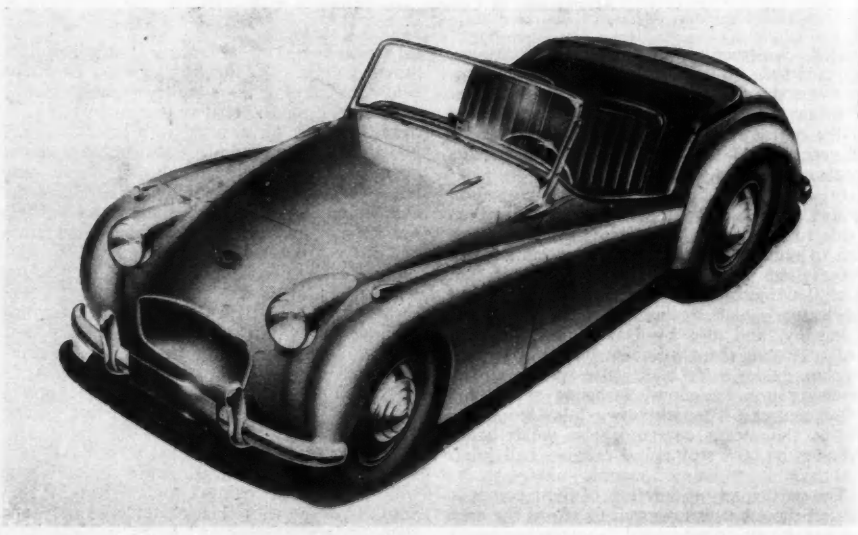


Fig. 1—Triumph 2-litre Sports Car

of spare parts, are so obvious that it is likely to become more popular. Similar advantages can be derived from agreements between individual firms for the purpose of eliminating mutual competition by cars of substantially similar characteristics. The formation of the British Motor Corporation in November last, which was a merger of the Nuffield and Austin groups of companies, might be the first step in the direction of reducing the considerable number of individual models made by the various factories of the Corporation.

The first general impression gained at the exhibition is that, at least in the car section,

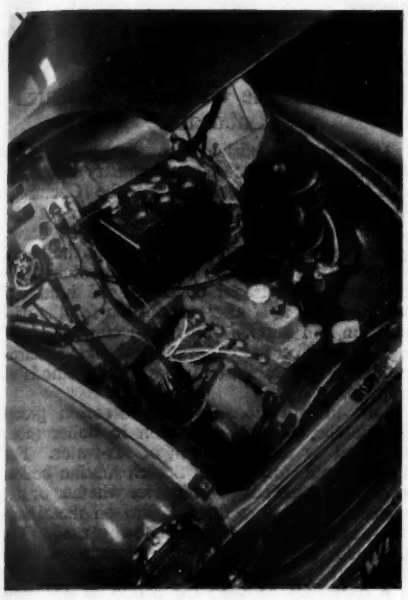


Fig. 2—New 803 c.c. o.h.v. engine in the Morris "Minor"

there is no marked break away from previous styles, nor are there any remarkable or novel technical features. There are, however, considerable detail modifications based on road experience and alterations resulting from the adoption of advanced manufacturing methods. This should not be regarded as a sign of stagnation, but seems to confirm the belief that the design of the post-war British car is thoroughly sound, needing only minor mechanical changes to keep the present models abreast of technical development. This policy is entirely in conformity with that of Continental and American motor manufacturers, who nowadays change their models only drastically when circumstances dictate such a change and confine themselves in the meantime to improve acknowledged sound designs in the light of suggestions received from users all over the world. Such design modifications, self-evident as they are, frequently pass quite unnoticed by the public, but they are just as essential to the quality of the finished product as innovations of a more spectacular nature.

Lack of space prevents us from mentioning more than just a few of these alterations, which frequently consist of modifications in the arrangement of instruments, better protection from dust and draught, improved heating and ventilation and roomier luggage accommodation. There are, however, some entirely new models which show imagination in conception and careful detail design, and which are to be more fully described. They comprise the latest Humber "Snipe," the Wolseley "Four-Fortyfour," and the Armstrong-Siddeley "Sapphire."

Turning now to the various stands, it is to be noted that, as far as the "Big Six" are concerned, the well-known Austin, Ford and Standard models, apart from insignificant detail alterations, are the same as those exhibited last year. At the stand of the Austin Motor Company, a new drop-head coupe body on the "A.40" chassis is on view, and there is now sufficient opportunity of studying in greater detail the rejuvenated "Seven" or, to give the car its proper name, the "A.30." This car, which made its first appearance at last year's show, is, indeed, what it is supposed to be, namely a "big car in miniature," with all the refinements possible in a car of that size. Even those critics who feel that the problem of a popular "utility" car should have been approached in a less conventional way must be impressed by the skilful detail design not only of the stressed-skin body, but also of all the major components and particularly that of the engine. Production has not yet reached full stride, but there is little doubt that not only a great number of former owners of the old "Seven," but many new customers will be looking forward to its general release.

At the Ford stand, a comparison between the new "Consul" and "Zephyr" models, first introduced at the 1950 show, with the older "Anglia" and "Prefect" types, demonstrates clearly the progress made in the last twenty years in automobile development. The two latter models, incidentally, are the cheapest cars in world markets and, though lacking the performance, the road-holding and the riding comfort of modern designs, are still enjoying considerable popularity because of their simple construction, the reliability of all their major components, and the service facilities of the widely-spread Ford sales organisation. The six-cylinder "Zephyr," convertible with power operation of the head by push-button control, first shown last year, is not in full production yet, but will be available shortly.

The Standard group has introduced a new Triumph sports car (Fig. 1) of very attractive appearance, fitted with a short-stroke, 2-litre engine (83mm by 96mm), which is a developed version of the power unit used in the Triumph "Renown." This engine, a distinctive feature of which is the quickly-detachable wet cylinder liners, has an output of 75 b.h.p. at 4500 r.p.m.

The Vauxhall Motors Company last year introduced two new models, the "Wyvern" and the "Velox," which represented an entirely new conception with the exception of their long-stroke engines which were a legacy from cars of the previous series. Since last spring, these cars have been fitted with short-stroke engines of only slightly bigger capacity, but considerably higher speed. With a bore of 79·4mm and a stroke of 76·2mm, the four-cylinder engine of 1·5 litre capacity now develops 40 b.h.p., and the six-cylinder 46 b.h.p. at 4000 r.p.m. Owing to the shorter stroke, the piston speed is about the same as that of the previous engines, and there is a gain in maximum torque resulting in a better range of performance. In our last year's report we commented favourably on the Vauxhall cars, but had certain doubts as to whether the 35 h.p. engine of the now heavier "Wyvern" would provide the acceleration and flexibility which is essential nowadays, especially in urban traffic. This criticism is not justified any more in view of the increased output which, incidentally, has no effect on the well-known economy of the engine.

At the stands of the Morris Motors Company, both the two-door Morris "Minor" and the Morris "Oxford" models are similar to those previously shown, except for the new pressed-steel radiator grille, which is of somewhat different design from the die-cast zinc-alloy grille which has been used up to now. The four-door saloon, which is available for export only at the moment, is now powered by an o.h.v. engine of 803 c.c., which develops 30 b.h.p. at 4800 r.p.m. The new power unit, Fig. 2, is practically in every respect identical with the engine of the Austin "A.30"; it has a 1mm larger cylinder bore than the former Morris side-valve engine, but a 14mm shorter stroke, and develops 30 b.h.p., i.e. about 10 per cent more power at roughly the same piston speed and approximately the same fuel consumption. With the modified rear axle ratio, this should give the car an improved performance, and a maximum speed of 68 m.p.h. is now claimed.

A new car, made by Wolseley Motors, Ltd., another member of the Nuffield group, is the Wolseley "Four-Fortyfour," a very attractive four-door, five-seater saloon, powered by a 1250 c.c., o.h.v. engine, (Fig. 3). This design adds a 1½-litre car to the existing range, comprising a 1½ and a 2¼-litre model, but is, in its mechanical and structural conception, very different from these.

The car is of integral stressed-skin construction and it is interesting to note that the

Fig. 3—Wolseley "Four-Fortyfour" saloon

Fig. 4—Humber "Super Snipe" Saloon

deep propeller shaft tunnel has been designed as a stressed member, thereby increasing the beam stiffness of the car. By contrast to the other Wolseley cars which include torsion bar springing in the front suspension, the "Four-Fortyfour" is equipped with wishbones of uneven length and coil springs which envelop the double-acting telescopic dampers. The engine of 66·5mm bore and 90mm stroke has push-rod operated valves and, with a compression ratio of 7·2 : 1, develops 46 b.h.p. at 4800 r.p.m. In most basic details it is identical with the engine of the M.G.

With a dry-weight of 22½ cwt, the car is not primarily intended as a high-performance model, but rather as a vehicle offering comfort and refinement in the four-seater class. The interior is tastefully planned and has leather upholstery, "Dunlopillo" foam rubber cushions, polished walnut fascia panel and several other luxury details which will appeal to the more discriminating class of customers.

The Rootes Group of Companies introduces a new version of the Humber "Super Snipe" Fig. 4. Not only has the body been completely redesigned, but the latest model also has a new chassis, Fig. 5, with coil spring front suspension. The direct-acting telescopic dampers are housed inside the coil springs, and a torsion bar, acting as a roll stabiliser, is fitted between the suspension links.

The six-cylinder o.h.v. engine, of 90mm bore and 110mm stroke, has a closer bore/stroke ratio (1 : 1·25, compared with 1 : 1·4) than its predecessor and, with a compression ratio of 6·48 : 1, it develops 113 b.h.p. at the very moderate speed of 3400 r.p.m. The generously-dimensioned crankshaft is carried in seven main bearings and the overhead valves, which are arranged vertically and in line, are operated by push-rods from a low chain-driven crankshaft. Each valve is fitted with two concentric springs and, in accordance with modern practice, the inlet valves are larger than the exhaust. The lozenge-shaped combustion chamber is designed to give high thermal efficiency and is fully machined. Smoother running and less cylinder wear are achieved by tin-plating of the split-skirt pistons and by chrome plating of the top rings. In addition to the two compression rings and one scraper, an additional ring groove is provided at the bottom of the piston skirt to accommodate a fourth ring in case further oil control becomes necessary after long use.

The torque is transmitted through a dry, single-plate clutch to the four-speed gearbox, which has synchromesh on all forward speeds. The rear axle is of the three-quarter floating kind, with hypoid bevel final drive. A new feature of the transmission is the use of internal splines in the gearbox for the sliding joint of the propeller shaft, which is thus completely enclosed in the gearbox and adequately lubricated.

The body has pleasing and symmetrical lines and retains the characteristic British frontal treatment of radiator and wings. The luggage compartment is exceptionally roomy, and the spare wheel, which is carried vertically, is recessed into a well so that it can be withdrawn without disturbing the luggage.

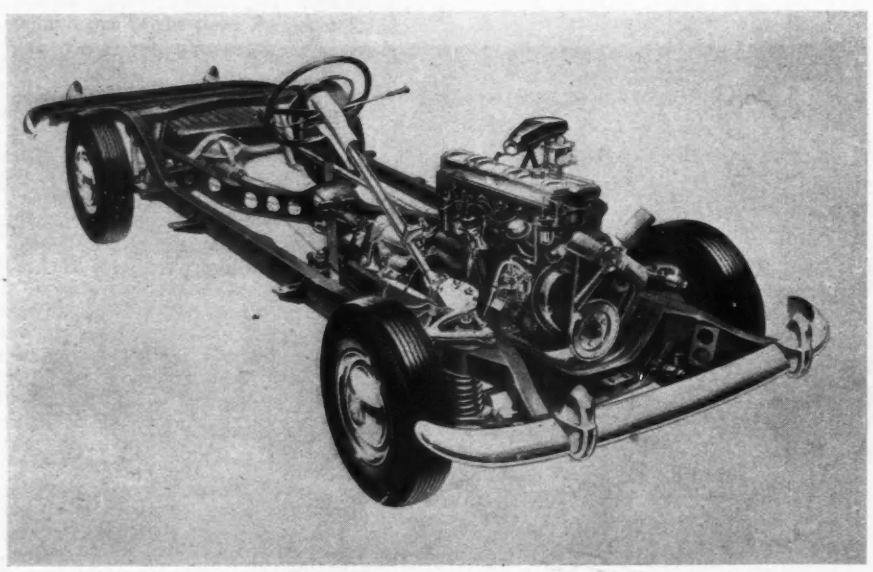


Fig. 5—Chassis of the Humber "Super Snipe"

(*To be continued*)

Report of the Chemical Research Laboratory

THE report published this week, by H.M. Stationery Office, entitled "Chemistry Research, 1951," contains the report of the Chemistry Research Board and of the Director of the Laboratory. In its report the Board draws special attention to the direct services the Laboratory renders to industry. It maintains, for example, the national collection of industrial bacteria, and it is also responsible for the preparation and supply of organic compounds of high purity for the calibration of mass spectrometers and as standards in physical methods of analysis.

New investigations by the corrosion group include the study of corrosion in boiler tubes produced by the infiltration of sea-water. For this research, four model Scotch marine boilers have been installed. To discover whether or not corrosion inhibitors form a film on metal surfaces, radio-active tracers are being used. The electrode potential of steel specimens pre-immersed in the solutions, has shown that there is a difference between the action of chromate and benzoate. The group was asked for advice on the cleaning of some archæological finds from a site near York. Although buried for over 1000 years in water-logged, peaty soil, iron and other metal articles were only slightly corroded.

The radio-chemical group has continued to be mainly concerned with the analysis of minerals and ores and the development of methods for the extraction and recovery of uranium and other valuable metals from low-grade ores. Separation by chromatography has been extended to many metals, including niobium, tantalum, gold, platinum, iridium, and so on. Metals such as gold, nickel, iron and cobalt have been separated from solution by ion-exchange resins. This process, the report maintains, appears to have a commercial future.

The inorganic group has developed a radio-active tracer method for following the elimination of arsenic, the most important impurity from germanium. By distillation of germanium tetrachloride in the presence of hydrogen chloride and chlorine, the arsenic content of the resulting germanium dioxide was reduced to one part in 1 thousand million.

Work on precise measurements of vapour pressures and boiling points of bases of the pyridine series has been resumed. The high polymers group has continued studies of the ion-exchange and allied properties of high polymers and investigations on the fractionation of polymers according to chain length. An outstanding discovery is the preparation of improved semi-permeable membranes for use in the determination of molecular weights by osmometry. These membranes, made from polyvinyl alcohol, give rapid and reliable measurements of the number-average molecular weights of polymers of relatively low degrees of polymerisation. A patent has been applied for.

Investigations on the production of sulphur are being pursued as a first objective by the microbiology group. A team from the laboratory is now employing, for the microbiological reduction of sulphate, a continuous process developed by the experimental station of the Ministry of Supply at Porton.

Prestressed Concrete Hangars at London Airport

As part of the extensive programme of constructional work at present in progress at London Airport, some hangars have recently been built for British European Airways. The group of ten hangars and workshops in the complete scheme constitutes one of the largest prestressed concrete buildings yet erected.

WHEN the British European Airways' transfer from Northolt to London Airport was decided on after the war, it became necessary to construct hangars and maintenance buildings on the new site for housing and servicing the corporation's aircraft. The contract for the buildings was placed as a result of a competition organised by the Ministry of Civil Aviation. Some twenty well-known contractors were asked to submit tenders based on either steel, normal reinforced concrete or prestressed concrete construction to plans and specifications prepared by the Ministry. The winning design combines reinforced and prestressed, precast and *in situ* concrete, and also introduces small quantities of aluminium and structural steel.

The buildings, which are in the south-west corner of the airfield, can be seen from the Great South West Road to Staines. With a ground plan about 1000ft long by 465ft wide, they cover in all an area of approximately 100 acres. The ensemble consists of two rows of five hangars, each facing outwards ; between them are two separate rows of workshops, each communicating with its row of hangars and separated by an access road. At the end of the building is a stores shed passing right across the whole width of the hangars and workshops. Each row of hangars has a total length of 900ft and a width of 211ft ; the stores block is 465ft long and 100ft deep.

Each row of five hangars is 900ft long and 110ft wide. For purposes of construction, each arm has been divided into five 180ft bays, each with its own 150ft wide entrance closed by power-operated, folding, sliding doors. Internally, however, there is no division between the bays, giving a clear space of 900ft by 110ft, and 43ft high to the underside of the roof beams. The clear height under the doors was required to be 30ft ; the extra height to the roof beams was necessary to accommodate travelling gantry cranes without the hook level being lower than the door soffit.

The workshops behind are considerably lower, and consist of a strip 40ft wide and 22ft high adjoining the hangars, with a second section 40ft wide behind it, where an additional floor has been added, making the height here approximately 32ft. The illustrations herewith give an idea of the construction of the hangars and of the appearance of the completed structure.

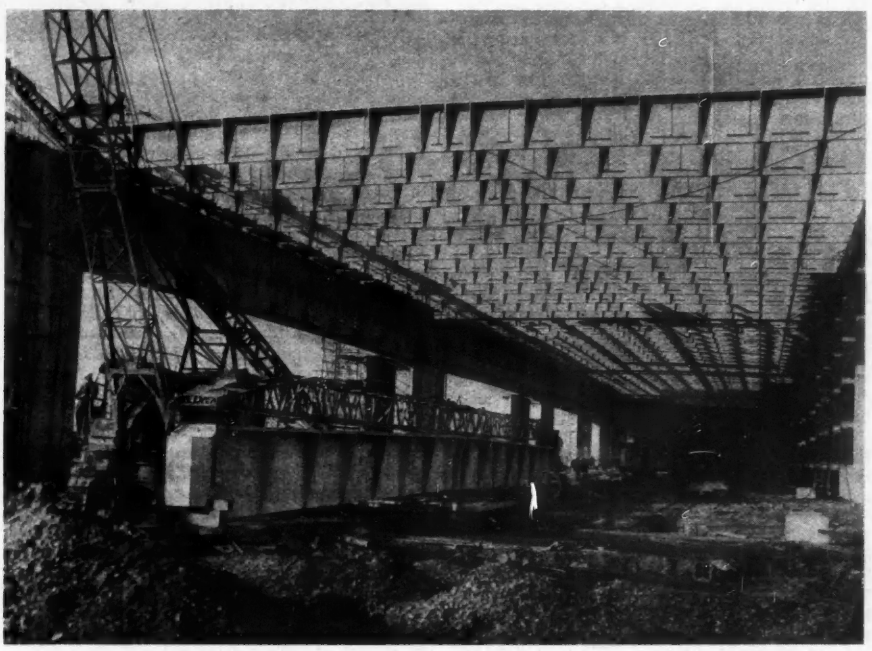
Work on the site was started in the summer of 1950. Before construction could begin, a good deal of excavation was necessary. The site consists of 1ft of topsoil overlying about 2ft of brick earth, with below about 12ft of gravel lying on clay. A depth of about 4ft was therefore excavated over all the site, and filled in with gravel, which was compacted in 8in layers. The reinforced concrete foundations were taken down 4ft to the natural gravel; where the gravel was deeper, however, they were extended in mass concrete. The foundation depth was thus generally between 4ft and 7ft below ground level. Normally, the watertable was 9ft below ground, but in February, 1951, it rose to 6ft, and that level persisted into the summer, so that heavy pumping was necessary during much of the foundation and drainage work.

The hangars have a main front composed of reinforced concrete pylons carrying prestressed frontal beams over the 150ft door openings.

These beams are of *in situ* concrete and are stiffened with precast prestressed diaphragms. The roof is formed with sectionally-precast prestressed (secondary) beams, which span the 110ft between the frontal (primary) beams and the eaves beam of the rear wall. Resting on these beams are precast prestressed purlins that carry aluminium roof decking.

The pylons, which are 30ft wide and 5ft 3in deep, excluding the door housing, are of hollow box-section, with walls 4in thick. At one end of each pylon, however, is incorporated a solid column, which is separated by a construction joint from the remainder of the pylon ; one end of the overspanning beam is, in each case, carried on this independent column, making the necessary provision for movement. Wherever the beams bear on a pylon expansion joints are provided. A reinforced concrete wall panel standing in front of each pylon forms the housing for the sliding folding doors. The rear wall of the hangars is constructed with reinforced concrete columns placed at 30ft centres and carrying reinforced concrete eaves beams. The wall infilling consists of 6in thick reinforced concrete panels to a height of 24ft 9in with glazing above.

The design of the primary and secondary beams of the hangars has been the subject of a paper, which was presented at the Institution of Structural Engineers on October 23rd.* The next section of this article and the diagrams of the beams and the stiffening diaphragm have been reproduced from the paper.



Erection of Secondary Beams

Design Factors

Each hangar was required to be completely separate structurally from its neighbours, to enable hangars to be occupied and put into service as they were completed. Each hangar roof thus took on the aspect of a rectangle supported along one side and at two corners.

Initially, the scheme provided tracks for two 55ft cranes bearing on a common beam at the middle of the 110ft span passing right through the whole length of the row of hangars. This was later amended to a provision for cranes spanning the whole 110ft span.

A total of 45 per cent of roof area was to be glazed.

The major factors in the choice of structural form were the following : -

(1) The loads on the centre crane rail could reach a maximum value of two point loads of 22·5 tons each at 16ft centres. These loads gave the roof the character more of a highway bridge than a simple roof, and it was thought advisable to employ solid web beams supporting lightweight decking. Other possibilities suggested themselves (shell construction as at Karachi, bowstring girders, &c.), but a solid web girder seemed the only form whose shear and fatigue strength could be relied upon with sufficient certitude under such heavy concentrated loads.

(2) Each hangar had to be structurally separate from its neighbours. Any thought of making either primary or secondary beams continuous over several hangars had, therefore, to be rejected, and the solution was adopted of erecting a primary structure over the door, supporting a secondary one spanning between the door and the wall at the back. The beams constituting the primary and secondary structures will be considered separately.

Primary Beams.—These beams were subjected to loading caused by dead load and live load on the main roof, live load of the cranes, and dead load and live load on the canopy. Some or all of these loads could necessarily be applied off centre; the roof and canopy live loads, moreover, could be either positive or negative. Horizontal wind loads had also to be considered and, unless the rear wall were made much stiffer than would otherwise be necessary, these could only be carried by the primary beam. This beam has thus to carry both torsion and horizontal bending as well as vertical bending. Two solutions were considered :

(1) Making the beam flexible in torsion and fixing it to the ends of the secondary beams, thus translating all torsional effects into bending of these beams, the horizontal loads being carried by the back wall acting as a cantilever. This solution seemed highly complicated in erection ; it had the advantage of saving headroom, but there was, in fact, no difficulty in fitting the alternative scheme into the vertical dimensions specified.

(2) Making the beam stiff and thereby supporting on it all horizontal and torsional effects. The beam being a large one in any case, no difficulty was found in designing it for this purpose and erection was greatly simplified, since the construction of this rigid "spine" could proceed without awaiting the secondary beams.

Consideration was given to making the door

* "Hangars at London Airport : Design of Large Span Prestressed Concrete Beams," by A. J. Harris.

beam rigid with its supports, thus constituting a portal. This was rejected more for reasons of prudence, perhaps, than for precise technical reasons. It was felt that while certain savings of material would result, they might well be outweighed by added erection complications. Technical objections did exist, however; notable amongst them was the fact that if the beam were to fill all the space between door soffit and roof beam soffit, for which a minimum dimension of 12ft had been specified, it would give an extremely stiff portal frame, one in which temperature effects would be troublesome. Furthermore, the minimum clear height specified was very little less than that required by an economically designed simply supported beam and the extra headroom could easily be made up by notching the ends of the secondary beams; in consequence, no significant saving of dead weight could be made by employing a portal. The only economy, therefore, would be that of steel in the beam, against which would be offset the steel required in the legs.

The door beam was thus to be box-shaped and simply supported. Preliminary calculations showed that 4in webs would carry quite comfortably all the shear stresses caused by bending and torsion and would be sufficiently stable against buckling if diaphragms were provided at each secondary beam bearing, i.e. at 15ft centres.

The next question was where to place the prestressing cables. Precedent exists for placing the cables in the central void (hangars at Melsbroeck, Brussels), and the idea has its attraction, particularly since, with the type of cables employed (Freyssinet cable), the protection problem can be neatly solved. This arrangement of cables, however, has serious disadvantages, notably :—

(1) If the cables are not solid with the webs, the prestressing force is *external* and tends to produce buckling; the webs must thus be made thicker, adding very considerably to the weight of the beam and to the quantities of steel.

(2) If the cables are not in the line of the webs, the end blocks are subjected to very heavy shear forces and must in consequence be substantial and heavily reinforced. With the cables lying within the webs, however, it is sufficient at the beam ends to thicken up the webs slightly and provide sufficient bracing to counter local buckling due to the support reaction.

(3) Unless the cables are led into and out of the bottom flange, there is an appreciable loss of eccentricity which reacts not only on the steel quantities but on the concrete section as well.

The main beam was therefore to be simply supported and box-shaped with the cables embedded in the concrete walls. Exact calculation started from this point.†

Secondary Beams.—The largest part of the load on the secondary beams being that due to the cranes, means were sought of distributing it, and a triangulated prestressed beam occupying the full depth between roof level and the hangar clearance level was designed. The distribution effect was greatly reduced by the interruption of this transverse stiffening beam every 180ft, but the effect was, nevertheless, considerable.

The beam was designed as a semi-infinite beam on an elastic foundation; the stiffness ratios were such that the secondary beams constituted a virtually continuous foundation, and the effect of discontinuity was appreciable, but small. An augmented secondary beam was provided at each end of the 180ft to carry the concentration of load at the extremities, The calculations were based on the theory set out in "Beams on Elastic Foundations," by Hetenyi and, including the effects of discontinuities and augmented beams, were straightforward; for the worst loaded beam, the penultimate beam, the point load was reduced from 22·5 tons to 9·4 tons, to which must be added the weight of the transverse beam which came to 2·3 tons. The point load had thus been halved.

The secondary beams thus being united by a very stiff transverse beam, conditions of transverse and torsional stability were greatly improved, and a simple "I" section, with occasional stiffening diaphragms, was found satisfactory.

The scheme having been drawn up on these lines, the authorities decided to replace the two cranes by one large one spanning clear from the door to the wall. This removed all point load from the secondary beams and changed their character entirely; the reasons which had seemed to demand a solid web no longer existed. It was too late, however, to recast completely the scheme for the secondary beams and in consequence they were modified for the lighter loading by removing the bottom flange and reducing the number of cables. The "T" beam thus resulting is of a form not often economic in prestressed concrete, unless dead load is preponderant, which is not the case here; an examination of the stress values, however, showed that the strength of the concrete was fairly fully mobilised. The simplicity of shape aided casting.

Lateral stability required attention; the breadth/span ratio of the beams was 1/36. While this would be sufficient during short periods unloaded, it would not be sufficient under full load and over long periods. Arrangements were made, therefore, to provide lateral bracing by means of the beams carrying the lanterns. Similarly, the web and flange were very slender and it was necessary to unite them by means of frequently spaced diaphragms.

Construction Procedure and its Bearing on the Design.—The scheme being prepared in close collaboration with the contractors, erection problems were dealt with, as they should be, prior to detailed design to the benefit of the works as a whole. The construction aspects which had a bearing on design were as follows :—

The first problem was : to precast or not to precast the primary beams. The contractors decided against on the following grounds :

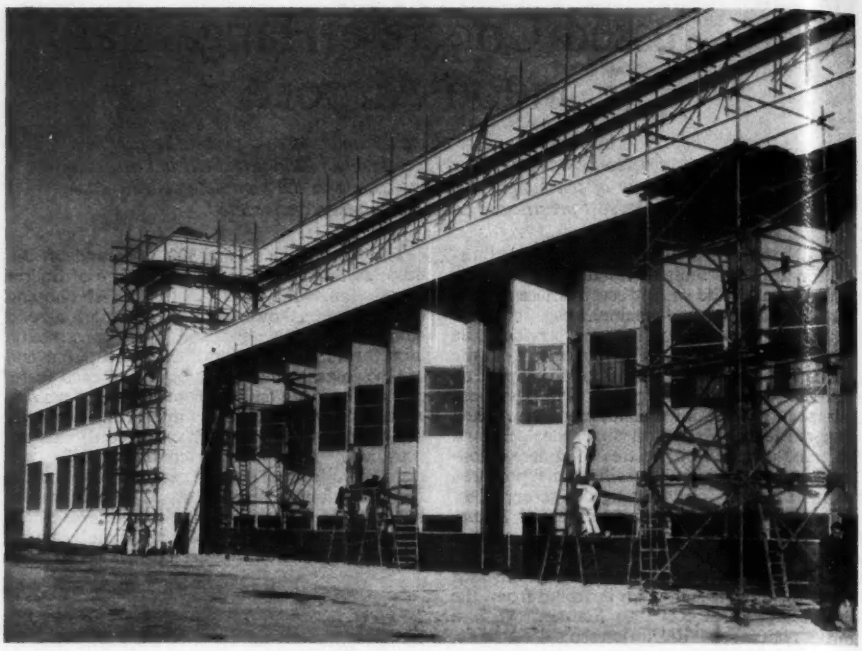
(*a*) The sectional area of the main beam is 2035 square inches. The segments could not reasonably weigh less than 5 tons and this, in view of the slenderness of the sections, meant delicate handling.

(*b*) Lacking experience of such large segments, it was difficult to foresee what degree of exactitude could be relied upon in overall dimensions, positioning of holes, &c.

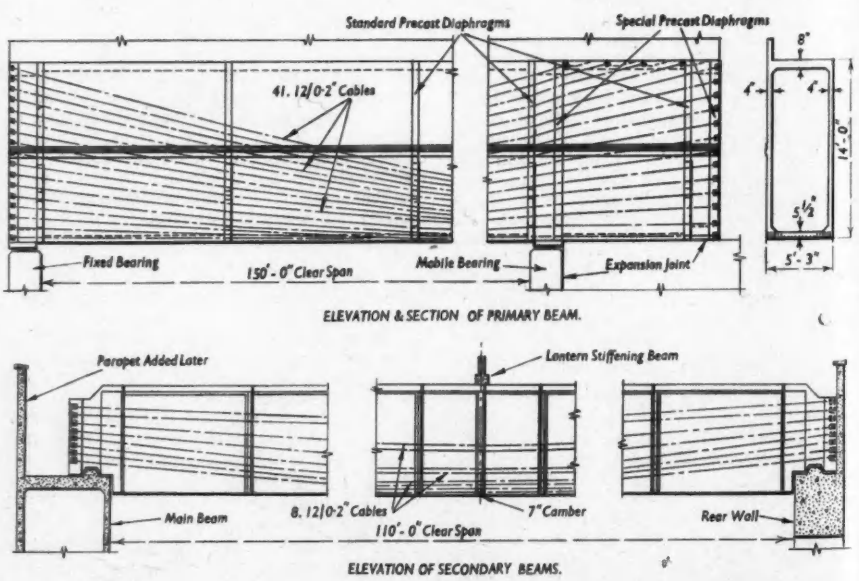
Accordingly, it was thought prudent to cast the walls *in situ*.

The diaphragms, however, presented a different problem. One was required every 15ft to carry the concentrated load from the secondary beam; it was a simple matter to combine with this dia-

† An outline of the calculation is given in the original paper.



Stores Block and First Bay of Hangar



Beam Details

phragm a cantilever to carry the canopy and a bracket to carry the crane beam, thereby concentrating in this element all the special features met with along the length of the beam. More, by precasting these diaphragms with holes to carry the main beam cables, they would greatly simplify the work of fixing the steel and the formwork. So it was done ; special diaphragms occurred at the beam ends to carry the anchorage cones and all these precast elements were placed on the falsework, the cables threaded through them (the cables required little other support) and the formwork fixed. The *in situ* concreting was thus reduced to the flanges and the webs.

The secondary beams could have been constructed in any of three ways :

(*a*) Cast *in situ*. This was obviously to be avoided if possible. The scaffolding and shuttering alone, not to speak of the labour for erecting, dismantling and displacing, would have been a very costly item.

(*b*) Cast in one piece elsewhere and handled into the final position. This was practical ; the handling operations were in no way too onerous since the beams would not weight much more than 25 tons. The beams could either have been cast on the ground near their final position and lifted up or cast on a staging and rolled into place along the top of the main beams. Nevertheless, to maintain the necessary progress, several sets of formwork would have been needed.

(*c*) Cast in segments. This was the method finally decided upon. Its advantages were the following :

(i) Greater precision in casting would be obtained and better control of quality. Inspection of each unit would reveal any defects ; should such appear, to reject a unit was a matter of much less gravity than to cut out a section of a beam cast in one piece.

(ii) From the progress point of view, it was convenient to be able to continue the casting of the secondary beams away from the main area of the works and stack the segments ready for use when required.

(iii) From the point of view of direct economy, the saving of formwork was most attractive and, in fact, segmental construction fully justified itself from this point of view. It is of interest to note that a total number of 122 beams, containing 3074 elements, were cast in nine moulds.

(iv) The difficulties of casting concrete down a 4in web around a line of cables running horizontally, difficulties which were accepted on the main beams, could be avoided by casting the segments on end, when the concrete would be placed along, rather than across, the line of the cables.

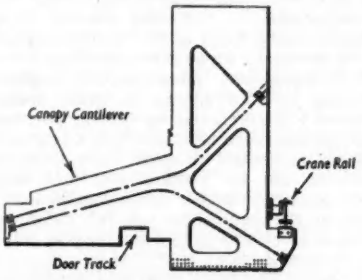
The main bearing upon design of the decision to employ segmental construction related to the stiffeners. It was obvious that so slender a web and flange would need frequent diaphragms ; such diaphragms would greatly complicate formwork were the beam to be cast in one piece. With segmental construction, however, to cast a diaphragm at one end of each segment so far from presenting any difficulties had certain positive advantages ; it stiffened each element during handling and provided an open mouth into which to drop the concrete during casting as well as stabilising the beam very effectively.

Practical Details.—In both beams, Freyssinet anchorages and cables were used of the twelve 0·2in type. The cables were sheathed in light steel tubes whose exact nature varied. according to the supply position. After stressing and anchoring, the cables were pressure grouted with 1 : 1¼ cement-sand mortar and the cone recesses sealed off with mortar.

The main problem with the primary beams was the disposition of the cables. The solution adopted was to group them in the centre as shown in sketch with one layer of twenty-one spaced evenly right across the bottom flange with a cover of 1in, and two layers of six and four above them, with ½in clear spacing, in each corner. This gave a distance of the centroid of the steel of 2·75in above the soffit. As the cables left the centre section, the outside vertical group of cables was swept up into the web, and the next vertical group was bent outwards to take its place and swept upwards in its turn. The phase-length, as it were, of this succession of cables was 15ft ; a diaphragm thus marked the point at which cables ceased to turn outwards and commenced to bend up. There was thus a double movement of cables outwards from the bottom flange and upwards into the web ; in the support section the process reached its conclusion with seven cables in the bottom flange and seventeen in each web. This gave a height of centroid above the soffit of 67in, and a very well distributed anchorage pattern. The locus of the cable centroid was approximately parabolic. While the double curvature would seem at first sight to lead to high friction losses, in fact it was not so, since the cables with large vertical curvature had only a minute horizontal curvature and the cables with maximum horizontal displacement in fact only bent out 15in in 75ft, with no vertical displacement at all. The bursting force caused by this slight outward spread was more than compensated by the reinforcement of the diaphragms.

At one end the beam rested on a very rigid box column. The support was composed of a steel plate bearing and the beam was held down by two Freyssinet cables anchored by hooked anchorages in the shaft of the column. This bearing was directly under a standard diaphragm and the beam projected 2ft 6in beyond this diaphragm and terminated in a special diaphragm carrying the anchorage cones. Over this length the beam webs were thickened to 12in.

There was a space of 30ft between the support axes of adjoining main beams ; in this 30ft had to be fitted the expansion joint and room had



Precast Diaphragm of Main Beam

to be left for the stressing jacks to operate since it was thought undesirable to stress a beam of this nature from one end only. In consequence, whilst at one end the beam projected only 2ft 6in beyond the support axis, at the other it projected 15ft in cantilever. The cable inclinations were continued across this 15ft, which resulted in some of the cones lying in the top surface of the beam. This produced no difficulties. This end of the beam rested on a flexible column, the bearing being similar to that at the other end.

The intervening 12ft 6in was cast *in situ* in reinforced concrete, the prestressing wires protruding from the fixed end being employed to bond in the reinforced work.

The expansion joint thus ran up the back of the flexible column, along the soffit of the cantilever and up the end of the cantilever.

Thirty-three cables were stressed when the concrete had set sufficiently ; the remaining eight cables were stressed as soon as the secondary beams in the centre of the span had been placed.

The cable trace in the secondary beams was complicated by the necessity of providing a number of holes in the beam web to carry lighting and other services. The employment of eight cables at a distance of 14in from the beam soffit to their centroid gave considerable flexibility in choosing the trace of each cable, and as a result it was possible at the same time to preserve a reasonable shape for each, to avoid the holes and obtained a roughly parabolic shape of the centroid locus.

The joints were ¾in wide and were filled with a 1 to 1 sand/cement mortar mixed earth dry and packed in hard with a hammer and chisel. The cables were protected from this mortar by a short length of tube passing across the joint and extending into bell-mouths cast in the ends of the adjacent elements. The cables were stressed twenty-four hours after the packing of the joints. One incident has to be remarked upon in this connection. One of the secondary beams having been successfully stressed, one of the joints failed about twelve hours after when the cable ducts were being washed through with water prior to being injected. The causes of this remain obscure, though it was probably due to the effect of the flow and pressure of water on a joint whose set for some reason was delayed. Extensive examination and testing by the contractors of the concrete in the joint and in the elements failed to produce any more likely explanation. At any rate, the stress was released, the damaged units replaced and the beam stressed up again without incident.

The end element carrying the anchorage cones was a fairly bulky piece of lightly reinforced concrete. It was notched on its top surface to carry the gutter and on its bottom surface to permit the flange to project below the upper level of the main beam. The beam end was required to be broad to prevent the overturning of the beam, and the top flange had to be carried through to the gutter to support the deck ; a simple though heavy shape was chosen to satisfy these needs and to add robustness to the extremities of a beam which would undergo a fair amount of handling. The bearing surface was recessed and fitted over a reinforced concrete ridge which thus gave the beam a mechanical key with the supporting structure at either end ; as has been remarked above, the columns at the back of the building were sufficiently flexible to permit of temperature movements without overstraining.

Pretensioned purlins were bolted down on to the secondary beams through holes cast in the flanges. A precast kerb was then bolted along the beam flange between the purlin ends and lightweight aluminium troughing laid on top, the whole being finished off with fibre-board and a bituminous felt finish, the felt being brought over the kerb and on to the beam flange in such a way that the beam flange formed a gutter.

The lanterns were formed by triangular-shaped precast beams placed on the secondary beams. The centre lantern beam coincided with a special diaphragm ; bars projected from each and *in situ* concrete cast around them ensured a joint of adequate strength.

Workshops

The workshops at the rear of the hangars are also of composite construction. They have columns precast on the site and factory-precast beams, and the floors are a combination of precast units and *in situ* concrete. The 80ft width of this 900ft long strip is divided into two 40ft wide sections by a central row of reinforced concrete columns placed at 15ft centres. These columns were precast on the site and have brackets which carry the 40ft span prestressed roof (and floor) beams. The beams were precast and pretensioned on the long-line system, and carry a proprietary system of flooring which acts as a roof to the single-storey front portion. The outer walls of the workshops are of reinforced concrete 5in thick, lined with wood wool panels which are used as permanent formwork.

The stores building is constructed with prestressed roof beams carried on reinforced concrete columns. Its structure is independent of that of the adjoining hangars. Extensive concrete aprons surround the hangars on all sides, with a car park at the front, where small office blocks adjoin the entrance to the central service road. By September, 1952, one of the hangar and workshop wings was completed and in use, as was the storehouse section. The second wing is now under construction.

For the hangars described above, the consulting engineers acting for British European Airways are Messrs. Scott and Wilson ; Ramsey, Murray and White are the architects associated with them. The design was carried out by the main contractors, Holland & Hannen and Cubitts, Ltd., in collaboration with the Concrete Development Company, Ltd., and the Prestressed Concrete Company, Ltd.; the latter firm was concerned with the design of the primary and secondary beams. Mr. A. E. Beer was retained by the contractors as consulting structural engineer in connection with the scheme.

The Public Works Exhibition

No. I

IN the columns below will be found a brief selection taken from the very extensive array of exhibits at the Public Works Exhibition, which opens at Olympia on Monday next. The Public Works and Municipal Services Congress and Exhibition—to give it its full title—will take place from Monday to Saturday, November 3rd-8th. The exhibition will be open from 10 a.m. to 6 p.m. each day, but the official opening, by Mr. Harold Macmillan, Minister of Housing and Local Government, and president of the Congress Council, will be at 2.30 on Monday.

At 3.30 on Monday the first of the papers of the Congress will be presented, and on each of the following four days some five or six papers will be presented for discussion. Most of the papers cover strictly municipal engineering subjects, but others are devoted to more general topics, such as "Why America Builds Better Roads," "Planning and Public Works," and "Sea Defences," to give only three examples from the various titles.

The exhibition itself covers a floor space of 235,000 square feet, and about 250 firms and other bodies are exhibiting. Plant and equipment of all sorts, and building techniques and materials all take their place at the exhibition. A number of developments in prefabricating buildings of various sorts may be seen, and amongst the engineering plant, upon which our account has been concentrated, there will be found a number of new designs of various kinds.

John Fowler and Co. (Leeds), Ltd.

Many points of interest will be found in the new "Challenger 4" crawler tractor shown by John Fowler and Co. (Leeds), Ltd., Leeds, 10, and illustrated in Fig. 1. This tractor is driven by a 150 b.h.p. six-cylinder diesel engine and provides 130 drawbar h.p. with a bottom gear pull of 28,500 lb. It weighs some 29,500 lb in full working order and the ground pressure is 6·63 lb per square inch.

The box design main frame of the tractor consists of two 1in thick steel plates, which run the full length of the hull, cross braced by the fuel tank, bevel gearbox and front and bottom sealing plates, and reinforced by cross beam mountings and top cross stays. The underside of the hull is smooth and free from projections and has a ground clearance of 15in. Each of the track frames is fabricated from two solid steel rectangular sections cross braced by heavy steel plate. These frames are mounted on a large diameter rear cross beam, which is attached to the hull, and they are free to pivot a limited amount in a vertical direction under the control of a double-cranked axle beam. This beam is cranked at each end in the form of a "Z" bar and is mounted on the hull in bronze bushes. Each end of the beam is connected by links to the track frames. The arrangement is such that an upward movement of one side results in an equal and downward movement of the other side, oscillation of the beam being controlled by two damper leaf springs, one on either side of the hull. This permits a large range of track movement, without affecting the stability of the tractor, and eliminates any tendency for the track frames to "toe" in or out. Furthermore, all shocks which are absorbed by the track frames are transmitted to the hull, no load being taken by the final drives.

Bolted to the bottom of each track frame are six track rollers. The roller units are hardened on the wearing surfaces and are of the centre thrust bushed type, with ample grease reservoirs and special dual-purpose seals. The two pedestal mounted track carrier rollers on each side are identical and interchangeable with the bottom rollers. In addition, the hubs and axles are interchangeable with those of the front idler wheels. The rear driving sprockets, track rollers, and idler wheels are the same as those used on the "Challenger 3" tractor made by the firm. The front idler wheels, which are mounted in cast steel forks and slide brackets, operate in guides attached to the track frames. Totally enclosed spring recoil units are anchored direct to the rear track frame pivot brackets.

The four-stroke, direct-injection engine is governed to 1500 r.p.m., at which speed it develops 150 b.h.p., and for starting purposes a small petrol engine is fitted to the tractor. The drive is transmitted through a dry single-plate clutch to the six forward and four reverse speed gearbox, which is flange mounted on the front of the bevel box. A fabricated bevel gearbox, which also forms a rear member between the frame side plates, is divided into three compartments. The bevel wheel and pinion run in the central compartment and each of the outer compartments contains a steering clutch and brake. On each side of the bevel box is a flange-mounted final drive unit incorporating a system of epicyclic reduction gears.

Steering is controlled on each side by a hand lever and a pedal, each operating a steering clutch and brake respectively. The left-hand pedal is provided with a locking latch for holding on gradients or parking.

Substantial mountings, drilled facings, &c., which form integral parts of the basic design of the tractor, are supplied as standard for the fitment of a full range of ancillary equipment. This range includes a cable operated dozer, a direct-acting hydraulic dozer, front and rear power control units, a mounted logging winch, &c.

Mackay Industrial Equipment, Ltd.

Together with three Fiat and one Allis Chalmers tractors shown by Mackay Industrial Equipment, Ltd., of Feltham, Middlesex, are examples of the firm's hydraulic angledozer units, timber towing winches and a "Merton" overhead loader.

This "Merton" overhead loader is designed for use with the Fordson Major tractor and has hitherto been supplied chiefly for the export market. As can be seen in the photograph reproduced in Fig. 2, the loader consists of a bridge-like structure extending from ground level in front of the tractor to a high point some distance at the rear. A 14 cubic feet bucket runs on flanged wheels on the outside members of the structure, along which it is hauled by cables from a power-driven winch. The winch drive is taken from the front of the tractor engine and is independent of the main clutch.

The machine is designed to work in a straight line between the stockpile or face and the truck or dumper used for transporting the material, and necessity for turning the tractor or changing direction is avoided. As the machine travels backwards and forwards in a direct line the operator only has to change gear from forward to reverse and there is no undue wear on the front axle or steering gear. In operation the machine is driven forwards with the bucket lowered to "crowd" it into the stockpile and the bucket is slightly elevated. The machine is then reversed till the top of the bridge overhangs the dumping point and elevation of the bucket restarted. Throughout its length of travel the bucket remains upright until it reaches the end of the bridge, where it swings over against the pressure of return coil springs and dumps its load. When the weight of the material is removed the return springs come into effect to swing the bucket back on to the supporting members, down which it gravitates to the loading position ready for the next operating cycle.

Blaw Knox, Ltd.

A display of earth-moving and constructional equipment is to be shown by Blaw Knox, Ltd., 94, Brompton Road, London, S.W.3. Much of this equipment has already been described in the columns of The Engineer, but amongst the new products exhibited are two new cable control units for tractors and the "BK-90" open-top scraper illustrated in Fig. 3.

This new scraper is designed for operation with tractors of 76–100 drawbar horsepull and it has a struck capacity of 7·6 cubic yards and a heaped capacity of 10·6 cubic yards. In full working order the scraper weighs 14,500 lb when empty and about 40,750 lb when full, the weight distribution being 55 per cent on the rear axle and 45 per cent on the front axle. The bowl, which has a reinforced double-skin

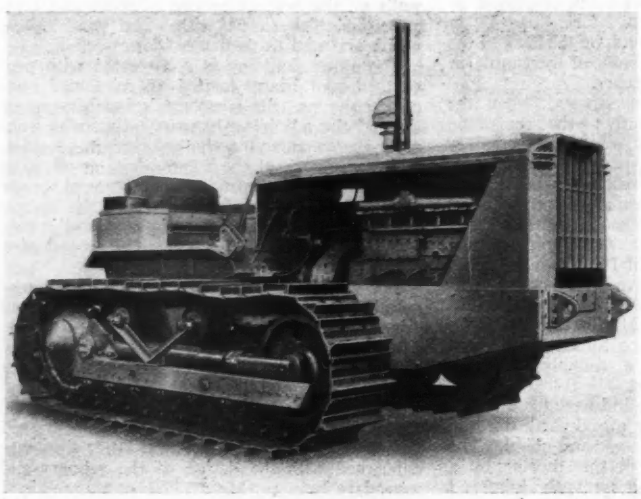


Fig. 1—150 h.p. Crawler Tractor—Fowler

Fig. 2—Merton Loader—Mackay

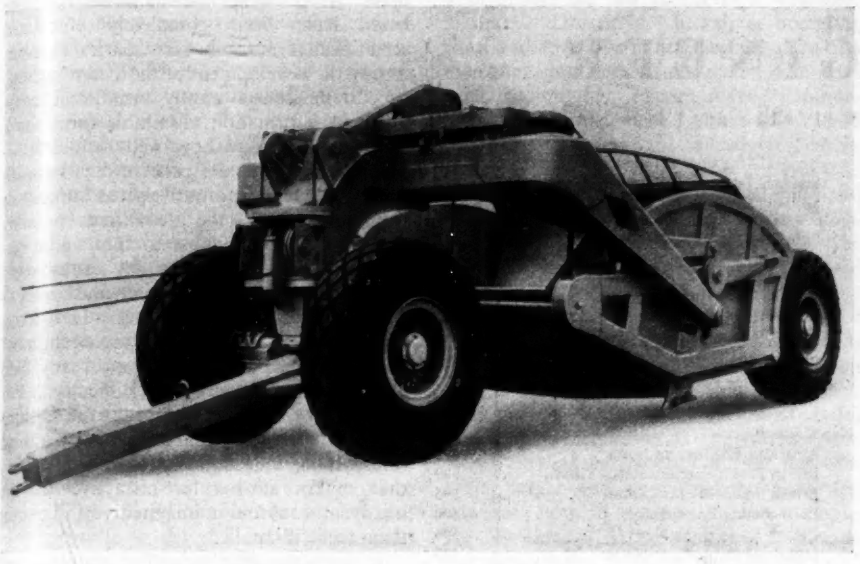


Fig. 3—Open Top Scraper—Blaw Knox

bottom, has an 8ft 6in by 2ft 2in floor with 4ft 3in high sides, a 4ft 5in high tailgate and a 2ft 3in high apron, the apron opening being 4ft 6in. A new design of concave blade 8ft 6in wide is fitted to the machine and the curved cutting edge of this blade gives a full "boiling" action throughout the loading operation. Reversible alloy steel side cutting blades are fitted. The machine cuts to a depth of 13in and spreads to a height of 22in.

The bowl design is such that with a minimum tailgate travel and the large apron opening a quick, controlled discharge is combined with even spreading. As in the other designs of scraper made by the firm, a positive ejection mechanism gives a smooth, powerful thrust to the tailgate during the discharging operation.

The "Y" yoke is built to give a very small overhang and close cutting to banks can be carried out without danger of damaging the apron side arms.

A ball joint connection between the yoke and the front axle allows free controlled movement between a tractor and the scraper even on the roughest terrain, and the location of the yoke hitch point is designed to give balanced penetration to ensure a high loading efficiency. All of the sheaves run on roller bearings and a new, simplified reeving arrangement has been introduced.

Other equipment exhibited includes one of the firm's "BK-12" heavy duty motor graders fitted with a Leyland six-cylinder diesel engine, developing 100 b.h.p. at 1650 r.p.m. Equipped with mechanical power operated controls, this grader has a 12ft blade with a full revolving circle and a wide range of adjustments. A "BK-50" ½ cubic yard excavator with a drag shovel attachment is also shown side by side with concrete mixers of various sizes, a concrete pump, &c.

Priestman Brothers, Ltd.

On the stand of Priestman Brothers Ltd., Hull the well-known ¾ yard "Wolf" excavator for general purposes in building and civil engineering operations is to be exhibited. Several improvements are being introduced into this and other machines made by the firm, including a new range of front-end equipment. The trencher, skimmer and luffing shovel in this range are based on the use of a single "Universal" jib, more simply converted from one to another than previously. In addition, the conversion to crowd shovel equipment has been greatly simplified. Long jib equipment includes dragline, grabbing crane and lifting crane for which again a common jib is employed, which can easily be extended from 32ft to 40ft in length whenever required. Special land drainage and irrigation equipments include side dragline and "Teredo" trencher. The "Wolf" crawler tracks have been increased in length to effect a substantial lowering of ground pressure, improving the manœuvrability of the machine on soft ground.

Department of Scientific and Industrial Research

Exhibits by the Building Research Station and the Road Research Laboratory may be seen on the D.S.I.R. stand. The Building Research Station has done a great deal of research on one-pipe plumbing, which is popular in America and in Continental countries but has not yet been adopted in this country, where the two-pipe system is traditional. It is claimed for the one-pipe system that the use of a single stack-pipe to receive the discharge from basin, bath, sink and water closet of a two-storey house gives improvement of appearance, particularly when the system is so designed that the vent pipes can be omitted. A full-scale installation built from transparent piping is to be shown and it is possible to trace the water flow and to see the ways in which the breaking of water seals by self siphonage and induced siphonage can be prevented.

The results of work on road safety are to be exhibited by the Road Research Laboratory. The relative risk of accident when crossing roads of different kinds, the motor accident rates on main roads and the accident risk caused by inefficient rear lights will be demonstrated. A model which can be operated by visitors will show how a poor rear light becomes indistinguishable when the overtaking vehicle is faced by the headlights of an oncoming vehicle. To demonstrate the operation of snow fences in preventing the formation of snow drifts on rural roads a closed circuit wind tunnel will be used. Model fences will demonstrate the way in which the drifting of snow can be controlled. The exhibit will also deal with road making and maintenance, including the use of soil cement stabilisation in road construction and the laying and testing of tar carpets and surface dressings. Included in the section dealing with the maintenance of concrete roads is the prototype of a machine recently developed for the resealing of joints.

(To be continued)

Auckland Harbour Bridge

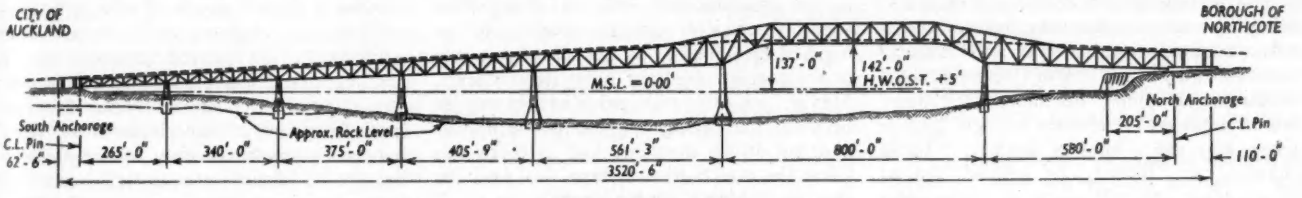
WE have received details of the proposed road bridge at Auckland Harbour, New Zealand, the contract for which has just been let. The bridge will cross the Waitemata River, and is shown in elevation in the accompanying illustration. The consulting engineers for this structure are Messrs. Freeman, Fox and Partners. The Auckland Harbour Bridge Authority, New Zealand, has now accepted the joint tender of two British firms, the Cleveland Bridge and Engineering Company, Ltd., and Dorman, Long and Co., Ltd., for the construction of the bridge. These two firms prepared the only British tender submitted, which had to meet strong foreign competition, particularly from Continental bridge builders. The value of the contract, it is stated, is £4,236,000, and each of the firms will fabricate approximately half of the steelwork and will work in association on the construction of the foundations and erection of the superstructure. The weight of steel in the bridge is approximately 10,000 tons, and it is estimated that the bridge will be completed in about four years.

The bridge will satisfy an urgent need in Auckland and has been under consideration for many years. Traffic across the harbour is at present carried by ferries and delay and congestion are severe. The contract will necessitate sending a large number of skilled men from this country to New Zealand, where they will be housed in a camp adjacent to the site.

The overall length of the bridge, which will link the city of Auckland with the borough of Northcote, will be 3520ft including an 800ft span over the navigation channel and six other spans. Designed in high-tensile steel of standard structural quality, the bridge superstructure will consist of a series of cantilever truss spans. The navigation span and the two adjacent spans will be linked together and connected to the north anchorage. At the third pier there will be an expansion joint in the structure and from there to the south shore the four tapering approach spans are to be similarly linked by pin joints and connected to the south anchorage. The navigation span will give a maximum clearance above high water of 142ft. The piers have been designed to resist earthquake shocks and are of hollow reinforced concrete construction. Considerable longitudinal movements of the bridge, caused by variations of temperature and loading, are to be accommodated by deep rocker bearings within the upper sections of the piers.

A roadway 55ft wide and two 6ft wide footways are to be provided, and the bridge will also carry water, gas and electric services in ducts under the footways. The roadway deck and the footways will consist of reinforced concrete slabs supported by welded steel stringers, whose top flanges will be bonded to the slab. The wearing surface of the road will be formed by an asphalt carpet.

The piers will be founded on the mudstone rock of the harbour bed and it is intended to construct all foundations under compressed air. Due to the great depth of water, it is thought that air pressures of up to 50 lb per square inch, the maximum pressure at which such work can be carried on, will be necessary.



Auckland Harbour Bridge

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EDUCATION AND ENGINEERING ART

What Sir David Pye said in his Presidential Address to the Institution of Mechanical Engineers on October 17th was not new. It has often been said before. But it was good to hear it said by one who has himself had so much experience of teaching; and fine to hear it expressed so admirably and with such authority. Sir David remarked, as those who read the excerpts, printed in our last issue, will remember, that the art of engineering "includes a very great deal that lies outside of formulated theory," that is based in fact upon intuition and the use of "rules of thumb," rather than upon scientific and mathematical knowledge. Rules of thumb are, of course, sneered at nowadays, more particularly by those whose education has been more scientific than practical. Lack of imagination in new design and failure to bring older designs up to date, the use, repeatedly, of conventional materials and failure to experiment with new, lack of interest in novel productive methods, resistance to change, are all amongst the charges brought against those who use "rules of thumb." Those charges can, indeed, be upheld against those—there are still many of them—who continue to depend too freely upon such rules when they have already been shown by mathematical analysis or scientific research to be either erroneous or inapplicable to the particular problem in hand. Yet it still remains true in the many fields "outside of formulated theory" that "the rule of thumb plays, and will always play, an important part."

But let it not be thought that it was Sir David's purpose only to exalt the value of such practical "rules of thumb." He would, we feel sure, be the last to apply such rules if research and analysis could demonstrate how to found a decision on a firmer basis. What he was stressing was that "all the theoretical training in which we teach 'a student' to manipulate formulæ on paper and to record experiments in a laboratory," takes him only a small part of the way to becoming an engineer; that, in fact, before he can become truly an engineer he must learn to appreciate the art, the intuition and the experience of people with a more practical and less scientific turn of mind. That art is found in many engineering places but nowhere probably is it more obviously apparent than in a design office. For though the simpler stresses in the separate parts of a complete new device, the rates of fluid flow, changes of pressure and temperature, and the effects of many other factors may be calculable, yet when it comes to the putting together of the whole there must, of necessity, be so much compromise that only intuitive skill of a high order allied with experience of the operation of similar machinery can produce a satisfactory result. For a machine is not designed as just a machine. It is designed for a particular application, to fit a particular space, to be cheap though good or as excellent as expense can make it, to be predominantly reliable rather than superbly efficient, or the reverse, to be handled by skilled or by unskilled operatives or to meet hundreds of other requirements. Maybe, too, there will need to be compromise between the speeds of the prime mover and the driven machine, just as there was when the direct drive turbine was used for ship propulsion. And upon the top of all these compromises, complicated by the variety of materials from which a designer can choose to make each part, the final creation must be as simple as possible to manufacture. Nor does art end with design. A host of practical considerations arises in manufacture as the production people decide how best to forge, cast, machine, finish and assemble the machine. Here, too, compromises will be necessary, dependent upon the capabilities of machines available, capacities of foundries, hardening plants, etc., not to speak of the possibility that the design itself may be modified in order to simplify processes of manufacture. All of this—it runs into operation and maintenance, too—is the art and practice of engineering and to much of it scientific and mathematical analysis is inapplicable, or at present, only partially applicable. Finally, it can be remarked of scarcely any machine save the very simplest that all the relevant factors upon which design calculations can be based have been completely elucidated scientifically. Just as Sir Charles Parsons, during the development of the steam turbine, had to devise on wholly insufficient aerodynamic information a suitable form for a turbine blade—and how well he did it!—so does many a designer to-day have to form judgments, intuitively as much as rationally, from the few and possibly irrelevant facts available to him upon certain matters and learn by subsequent experience—that is by trial and error—whether he is right or wrong. In all this the appeal to experience, to "rules of thumb" based upon experience, is a very ready help at moments of doubt and difficulty. For even though it be unadventurous the application of a "rule of thumb" is nearly always safe. It is, indeed, that element of safety that makes such rules attractive to the unadventurous and unimaginative and causes them to be ill-applied.

It is those with scientific training and imaginations ready enough to conceive and bold enough to attempt alternative solutions to old problems or to attack new ones who are so valuable to industry and in such short supply. Yet their exuberance needs to be tempered by knowledge of practical limitations and the practical experience of the past. Sir David, having stressed the importance of practice went on to ask "Can it be said that the creative mind is typical of the university graduate to-day?" How willingly we echo that question! For in one form or another, though never so clearly and forcibly as Sir David, we have repeatedly asked it for years past. By implication Sir David answers it in the negative. He proved in his address—he, who has spent a half of his working life amongst researchers and teachers at Oxford, Cambridge and University College, London—critical of engineering courses and examinations. "All the pressure of an over-full programme is brought to bear upon the somewhat sterile pursuit of solving artificial problems in engineering for examination purposes." He proved critical, too, of pressing mathematical instruction too far, remarking that "mathematical tests are ideal from the examiner's point of view," but certainly not indicative "of the seeds of a creative or instinctive engineer," whose aim is "to devise and construct." He would take normal mathematical instruction as far as the solution of first degree differential equations, leaving it only to those to whom mathematics comes easily to study the subject further. There was much food for thought in this address. Nor, we think, is the food only for the thinking of professors and educationists. The Institution itself, as a body deeply interested in engineering education, might also ponder it.

THE HELICOPTER AS AN ANTI-SUBMARINE CRAFT

In the Navy Estimates debate before the Easter recess the Parliamentary Secretary to the Admiralty made it clear that no definite decision had yet been reached on a building programme for aircraft carriers. Our future policy, he said, must be based on a comprehensive plan for a balanced carrier force—for fleet work and trade protection. If all

goes well under the rearmament programme, the Royal Navy will have twelve fast carriers by 1955. This number would be quite inadequate for Fleet—or, to use a modern term, Task Force—requirements were it not for the twenty-seven fleet carriers of the United States Navy. But five of the twelve Royal Navy carriers still require to have their flight decks and elevators strengthened and to be modernised if they are to be able to operate modern jet aircraft to compete on equal terms with enemy shore-based aircraft in offensive operations overseas. The reconstruction of five carriers is a building programme in itself, and the desirability of doing it has to be weighed against the urgent need for smaller carriers for anti-submarine operations. Improvements in radar have restored to aircraft much of the great value they had in World War II for convoy escort work. For in fine weather, when there are no waves to cause blobs of light on the radar screens, it is now possible to detect a submarine's snort by radar at a distance of several miles.

Unfortunately, the merchant ship type of carrier of about 9000 tons displacement and a speed of 16 knots, which did such valuable work as convoy escort during the last war, will not be able to operate modern anti-submarine aircraft. The weight and size of both detecting devices and weapons now being installed in anti-submarine aircraft have greatly increased since the war and the escort carrier of the future will require to be a ship of approximately the size, speed and performance of the 24-knot " Glory " class light fleet carrier. When the " Vengeance," which is being lent temporarily to Australia, and the " Magnificent," now on loan to Canada, are returned, the Royal Navy will still have only seven of these carriers and it will be difficult with our present resources both to build more of this class and also to modernise the five fleet carriers. Nor will it be easy to find suitable merchant ships for conversion to add to their number in war. There are, however, great hopes that the helicopter will go far to provide a solution. It was employed in the closing stages of the second world war for rescue work and since then both the Royal Navy and the United States Navy have employed it to transfer officers and dispatches from ship to shore. But it was not until the Korean campaign that the fullest use was made of the helicopter's unique ability to hover, to fly off in any direction and to land almost anywhere. Apart from the many daring and successful rescues of crashed pilots and wounded personnel from behind the enemy lines and of airmen from the sea, helicopters have been extensively used for observing and spotting shore bombardments providing, under certain conditions of weather, more accurate spotting than the conventional spotting aeroplane. They have also proved very valuable in locating North Korean minefields and assisting the minesweepers in sweeping a channel through them. Already L.S.T.s have been equipped with facilities for the continuous operation of helicopters in mined waters, and the design of larger ships is being considered by the United States Navy for the special purpose of carrying anti-mine helicopters.

It is, however, as an anti-submarine craft that the helicopter seems likely to prove particularly useful for naval purposes. Trials were carried out last year with a Westland-Sikorsky " Dragonfly " helicopter operating from a small platform fitted on the stern of a merchant ship and results up to date have been encouraging. The improved " Dragonfly "—used commercially either as a 10-12 seater passenger craft or for carrying cargo, and known as the " S55 "—has a useful load of over a ton, a range of some 460 miles and a cruising speed of 86 m.p.h. (maximum 110 m.p.h.). The " Dragonfly " would no doubt be unable to carry the radar and other essential anti-submarine equipment—such as " sono " buoys—but it could at least be employed to keep submarines submerged and prevent them following and shadowing a convoy on the surface and attacking in packs at night. This, indeed, was one of the most useful functions which aircraft operating from escort carriers carried out during the war. Much larger and stronger helicopters are, however, now in project, as, for example, the Westland " W85," with a maximum seating capacity of 100 or alternatively a disposable load of about 13½ tons. And as the helicopter lands on by " floating " down gradually—unlike the far heavier modern anti-submarine aircraft, which lands on at high speed—there should be no difficulty in giving the required extra strength to the after part of the deck and to the superimposed platform in a medium-sized merchant ship. The United States Navy has a new type of helicopter under design for the special purpose of operating against submarines. It is believed to have tandem rotors powered by a single engine of about 2000 h.p. Another design is in the experimental stage in the shape of a composite helicopter liaison aeroplane. It will hover and land on like a helicopter, but when airborne and at the required height, a forward driving propeller takes over for level flight. The helicopter, indeed, opens up great possibilities for the future. It would, it is true, provide a first-rate target for gunfire, but escort and other vessels would be operating in the vicinity and a submarine would be foolhardy in the extreme deliberately to come to the surface in an attempt to destroy it. It is, in fact, unlikely that a hostile submarine will risk surfacing in a future war from the time of leaving harbour until the completion of her patrol.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

A GAS-TURBINE LOCOMOTIVE EXPERIENCE

SIR,—My interest in Mr. Livesay's article in the issue of October 3rd was heightened by the disclosure of two items of news which have not, as yet, been announced by the Railway Executive.

The first item is that the Western Region no longer possess a Motive Power Depot of its own in the London area, Old Oak Common having been closed, and the locomotives transferred to the Willesden depot of the London Midland Region. No doubt it is part of the Railway Executive's economy campaign.

The second is that the down " Merchant Venturer " now slips a coach at Reading. This would appear to be a historic occurrence as, to the best of my recollection, coaches have never been slipped at Reading in the down direction and one cannot see any necessity for so doing. Possibly it is one of the attempts of the Railway Executive to give better facilities to the traveller, but one which would be of more use if it was publicly advertised.

Apart from these disclosures, the article is interesting in that it gives an insight into the working of a gas-turbine locomotive, but I agree with Mr. Nock that its value would have been enhanced by fuller details as to the position of the master controller at various points on the run.

J. C. HILL

Richmond, Surrey, October 23rd.

PREMIER GRADE PETROL

SIR,—On page 473 of your issue of October 10th, you have a note under the above head, in which a petroleum executive claims that the higher grade petrol (to be sold shortly as " branded ") will give greatly improved performance and more economical running with present engines. As, however, the compression ratios of the present engines will not be changed, one might think that with equal performance to the present (i.e. the same average speed), the economy (i.e. the m.p.g.) will be the same, but with improved performance the economy will be less.

Therefore, while the return of high-octane spirit will give us aviation petrol as well as permit improvements in new car engines, yet the retention of the sale of pool spirit gives solace to the present motorist, whose only general complaint against it is that the price is too high.

A. J. FIELD

Falkirk, October 15th.

NEGLECT OF TRANSPORT

SIR,—Your leader in the issue of October 17th, under the above heading, does well to stress the neglect that has afflicted various forms of British transport, particularly when efficient transport is so vital to the whole industrial system and economy.

For years, the issues of rail versus road have been fought with little measure of satisfaction, and yet the comparative increase in productivity of transportation as between the rail wagon and the road lorry is seldom brought out. Since 1914, the 10/12-ton rail wagon has hardly changed at all and, except for an insignificant number of recently-built wagons, only " parking " brakes are provided. In consequence, the average speed of goods trains remains at 10/15 miles per hour. (In a few goods trains where continuous brakes are fitted, average speeds of 45 m.p.h. are maintained.)

On the other hand, the capacity and average speeds of road lorries have increased many times during this period, with consequent increase in productivity of transportation.

Surely something is terribly deficient in top-level thought and action when not only has the more efficient system to be held back by out-of-date roads, but the speed of goods trains could be doubled or trebled by the fitting of continuous brakes.

Admittedly, it can be argued that there are no manpower or materials available at the present time for making the roads suitable for modern vehicles, but surely this could have been foreseen twenty-five years ago. Likewise, looking twenty-five years ahead, would it not be sound to operate many of the branch lines with frequent service rail buses or diesel railcars? Experience throughout the world not only shows a marked reduction in operating costs, as compared with steam, but in so many railways traffic is attracted back to them again.

On wonders how long it will be before Britain can enjoy the modern transportation which it is so capable of providing.

ANTONY VICKERS

Isleworth, Middlesex, October 27th.

Second European Machine Tool Exhibition, Hanover

No. III—(*Continued from page 545, October 24th*)

IN this article we continue our descriptions of some of the machine tools which were to be seen at the Second European Machine Tool Exhibition held recently at Hanover.

Beche and Grohs G.m.b.H.

The engineering works and iron foundry of Beche and Grohs G.m.b.H., of Huckeswagen, Rhineland, which is represented in this country by Leo. C. Steinle, of Marston Green, Birmingham, showed one of its compressed air-driven hammers for high-speed die-forging. Our illustration, Fig. 14, shows the machine, together with its air compressor and air storage vessel. Machines of this kind are made in seven sizes, having effective hammer blows ranging from 7250 up to 72,500ft-lbs, the number of blows per minute varying from 240 in the smallest hammer to 160 for the largest hammer. The number of blows per minute is varied by means of a special control valve, which operates independently of the hammer. This control valve is connected with a four-link motor-driven mechanism and forms part of an hydraulic system. On one of the links there is a sliding shoe, which is moved by a pedal near the front of the hammer and operation of this pedal adjusts the stroke of the valve and the movement of the hammer.

Franz Berrenberg

A high-duty frame saw for use in steel and iron works was exhibited on the stand of Franz Berrenberg, of Haan, in the Rhineland. Fig. 15 shows the machine cutting an octagonal steel ingot. The long guide ways for the saw frame are adjustable. The main shaft of the machine is driven by a 7 h.p. motor through vee-ropes. Three motors are provided, one for the main drive, one for lifting the saw frame at the end of the cutting stroke, and a third for the coolant pump. The work is gripped in a powerful vice fitted with a roller bed to facilitate movement of the ingot. The machine illustrated is designed to cut round ingots up to about 26in diameter, and rectangular bars up to 28in by 26in sections. The time required to cut through a 24in round or octagonal ingot of normal hardness is stated to be about 100 minutes. The speeds and feeds of the saw can be varied according to the hardness of the material to be cut, and the automatic feed range is from zero up to a little over $\frac{1}{8}$in per stroke. The saw blade made from a special steel, has high-speed steel teeth inserted in it, and it has a cutting width of between $\frac{3}{16}$in and $\frac{1}{4}$in.

H. Burgsmuller and Sohne G.m.b.H.

An interesting variation of the usual milling process, for the cutting of long threads, was demonstrated on the stand

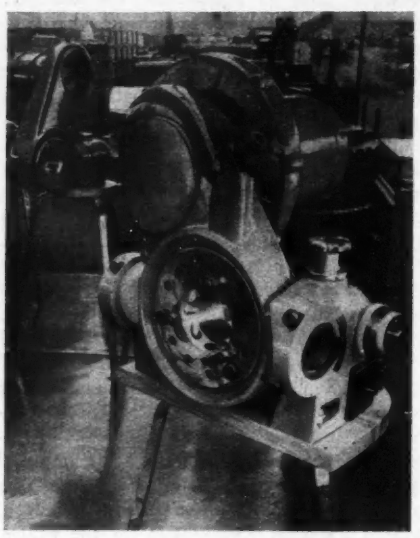


Fig. 16—Whirling Attachment for Cutting Long Threads—Burgsmuller

of H. Burgsmuller and Sohne G.m.b.H., of Kreiensen Harz. Instead of utilising a multi-tooth milling cutter running at a moderate speed, a very high-speed rotating tool-holder carrying only two or three cutting tools is driven at speeds from 1500 up to 3920 r.p.m. The attachment, which is illustrated in Fig. 16, is driven by a two-speed motor through vee belts. The tools are mounted in a hollow body, the mass of which acts as a flywheel in the centre plane of cutting pressure and stabilises the travel of the tool. The carbide-tipped tools are set by means of a stroboscopic optical system, the eyepiece of which can be seen at the top of the casing. In order to obtain a better flank cut the two tools are set to overlap on the faces, but are staggered a few thousandths of an inch in the flanks. By means of the optical arrangement the position of the tools and their cutting action

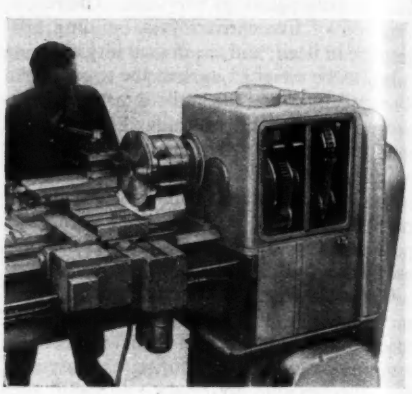


Fig. 17—Lathe with P.I.V. Headstock Gear—Werner Reimers

can be closely observed. The attachment shown has a special steady for guiding long workpieces. This steady is pressed against two hardened strips by hydraulic means and any small deviations in diameter are indicated by a pressure gauge so that suitable corrections can be made by a hand-operated recuperator piston. A special sliding tailstock centre is also used to eliminate the effects of longitudinal expansion. The attachment can be applied to any screw-cutting lathe having a minimum centre height of 5$\frac{1}{2}$in.

P.I.V. Antrieb Werner Reimers K.G.

A further development of the P.I.V. stepless drive for lathes was exhibited by P.I.V. Antrieb Werner Reimers K.G., of Bad Homburg v.d.H. As can be seen in the machine illustrated in Fig. 17, the P.I.V. drive is neatly housed in the headstock and this unit is combined with synchronous gearing through a magnetic coupling to give an increased range of speed control

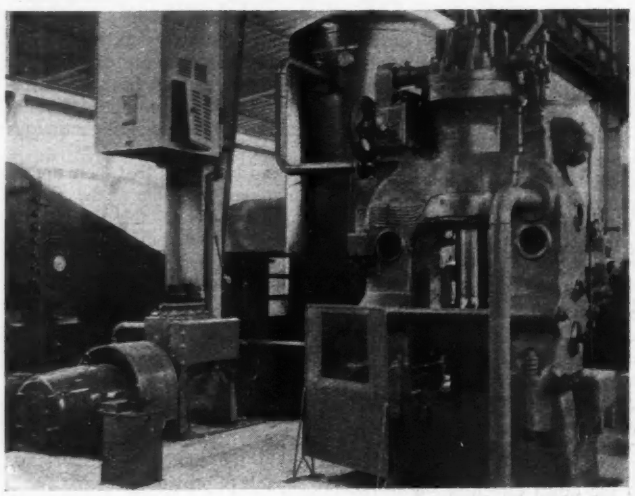


Fig. 14—High Speed Forging Hammer—Beche and Grohs

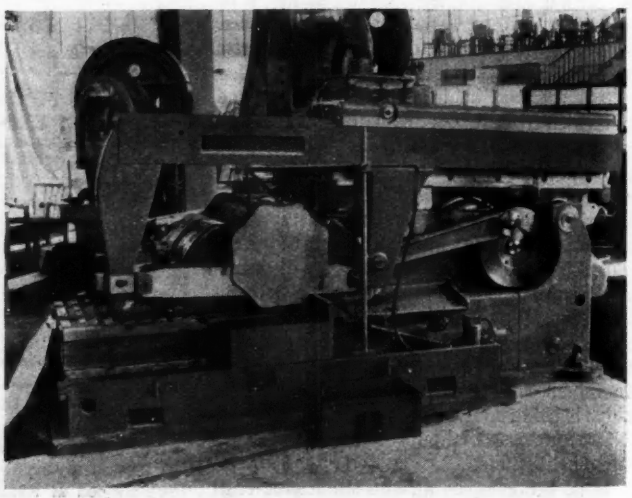


Fig. 15—High-Duty Frame Saw—Franz Berrenberg

from the original 1 : 7 ratio up to 1 : 50 and, if needed, 1 : 100. The headstock is fitted with a speed-changing gear which automatically varies the headstock speed to give a constant cutting speed irrespective of diameter when facing work is being done. The arrangement makes possible a continuous variable change of spindle speed from 50 to 1250 r.p.m.

Gebr. Heller G.m.b.H.

A large selection of production milling and boring machines were displayed on the stand of Gebr. Heller G.m.b.H., Maschinen-

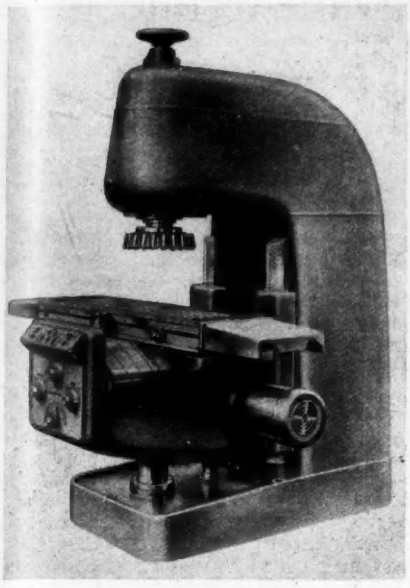


Fig. 18—Vertical Milling Machine with push-button control—Heller

fabrik, of Nurtingen, Wurtemberg, which is represented in this country by Wickman, Ltd., of Tile Hill, Coventry. One of these machines was a new production milling machine and another a special machine designed for the automobile industry. The vertical milling machine illustrated in Fig. 18 is the new FV 120, the horizontal counterpart of which was shown at Olympia recently.

An interesting point in the design of this machine is the use of electro-hydraulic control mechanism, operated through press-buttons arranged on a desk in front of the table. Through this control mechanism the lengthways, transverse and vertical table movements can be started and stopped and preselected speeds set in motion. The direction of the movements is indicated by signal lamps.

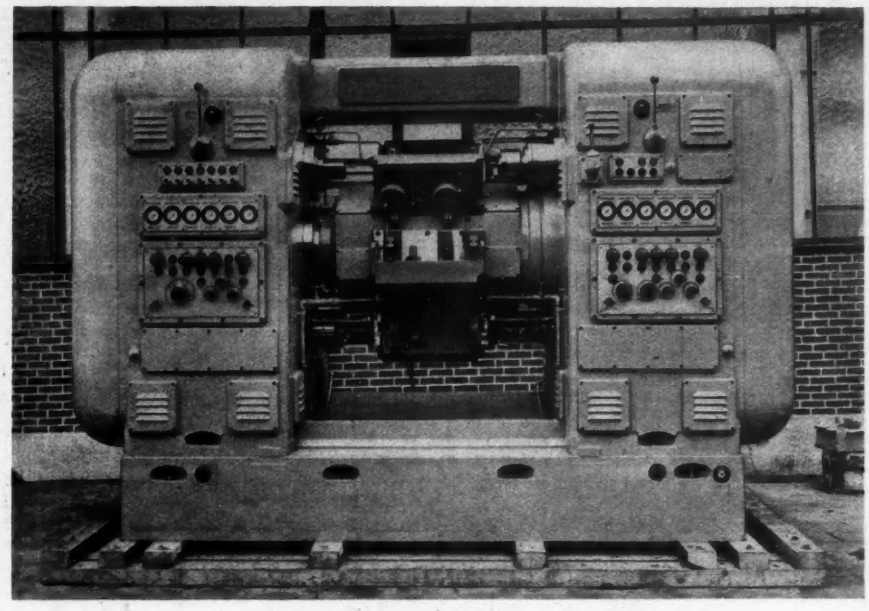


Fig. 19—Special Machine for Crankshaft Ends—Heller

The machine shown in Fig. 19 has been specially designed for the turning and boring of both ends of a motor-car crankshaft, the complete process taking only about one minute. The machine is of closed frame construction and the side supports carry the bearings for the six position indexing, central work-holding drum, as well as the motor-driven boring units, the hydraulic controls for quick movements and the feed and clamping mechanisms. In progressive operations at the six stations both ends of the crankshaft are bored and four holes in the flange are drilled. The various movements are controlled from the panels on the sides of the machine and the working pressure exerted on the tools is indicated on the dials. Other machines of this special class include one for the milling of crank-pins on crankshafts, which is said to show a considerable saving in machining costs compared with the normal turning process.

Eumuco A.G.

The firm of forging machine manufacturers, Eumuco A.G., of Leverkusen-Schlebusch, represented in England by S. C. Winfield-Smith and Co., Ltd., of Bourne Hill, Horsham, Sussex, showed an interesting new design of plate shears. This machine, Fig. 20, can be used for cuting square edges and for producing plates with edges bevelled at 30 deg. to 35 deg., ready for welding or caulking purposes. When cutting such bevels the plate and holder remain in the horizontal position, whilst the upper cutting blade is tilted by means of an electric motor. Resilient pressure pads are provided for holding down purposes and the precise location of the cut is ascertained by use of an optical indicator, through which is checked the lines marked out on the plate.

Another interesting machine shown on this stand was a high-speed drop hammer, which employs a roller chain for lifting the hammer. This chain is wound around a lifting disc of cam shape, which gives a low rate of acceleration at the commencement of the lift and a low speed at the end of the stroke. The design is such that blows of 1600 M kg can be struck at a rate of 55 per minute.

L. Burkhardt and Weber K.G.

The firm of L. Burkhardt and Weber K.G., of Reutlingen, Wurtemberg, which is known for its multi-spindle drilling machines, is represented in England by Lloyd and Ross, of 58, Victoria Street, London, S.W.1.

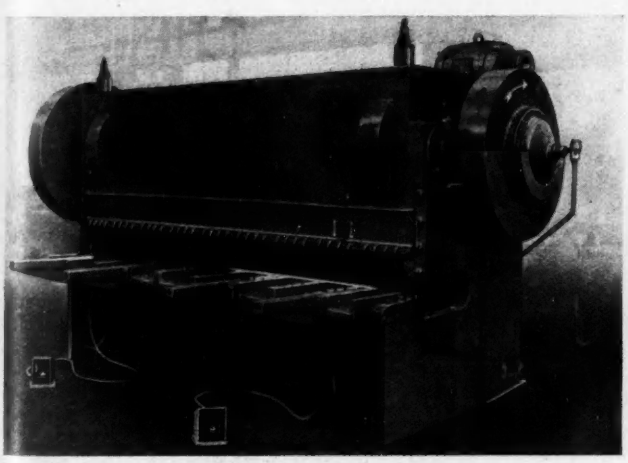


Fig. 20—Plate Shears with Tilting Upper Blade—Eumuco

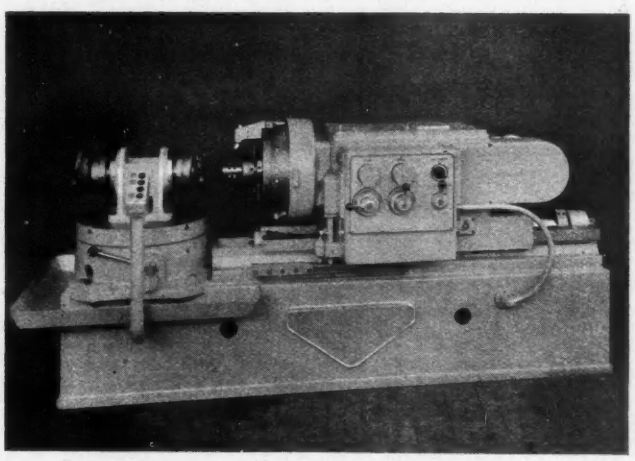


Fig. 21—Semi-Automatic Facing Lathe—Burkhardt

This company showed a three-head, hydraulically-operated drilling line, which has been built for the machining of four and six-cylinder engine blocks. The five operations involved are carried out with three boring heads and the cylinder blocks pass through the machine on a conveyor track. In the working cycle one hole is drilled at an angle of about 30 deg., the securing holes in the base of the block are drilled and tapped and the holes for the positioning pins drilled. An automatically-operated air hammer finally comes into use to drive in the pins.

Another machine on the same stand was the facing and boring lathe, shown in Fig. 21, which is designed for the boring, facing and recessing of flanged castings. The work is carried on a rotating table, which is hand-indexed between the loading and machining stations. The headstock and the work fixture are mounted on a welded steel base.

Heyligenstaedt and Co., G.m.b.H.

Another type of lathe for large facing work for which the above-mentioned P.I.V. infinitely variable drive can be employed was shown on the stand of Heyligenstaedt and Co., Werkzeugmaschinenfabrik G.m.b.H., Giessen. This firm is represented in this country by Leo C. Steinle, Ltd., of Marston Green, Birmingham. The machine which is shown in Fig. 22 is the largest of three sizes and has a centre height of 1120mm and a faceplate diameter of 2200mm. This faceplate diameter can be increased to 4000mm if the machine is built over a pit. The machine is driven by a 30 h.p. motor and it has a spindle speed range of from 0·75 to 38 r.p.m. The cross bed carrying two saddles has its own motor drive.

Herman Kolb G.m.b.H.

Drilling machines were shown on the stand of Herman Kolb G.m.b.H., of Koln-Ehrenfeld, which is represented in this country by Mr. Stanley Howard, 75–76, Exchange Buildings, Stephenson Place, Birmingham, 2. This equipment included a new high precision radial drilling machine with optical measuring attachments on the table and saddle. This drilling machine is mounted on a heavy bedplate which carries the main supporting column, and a second support column for the outer end of the arm, making a closed frame. The arm is clamped to both columns by push-button-controlled electro-hydraulic means. The machine has a table area of 1000mm by 1750mm. Movement of the table and the saddle can be set at 1000mm per minute or 100mm per minute. The spindle has a range of twenty-four speeds, from 19 to 1320 r.p.m., and eighteen feeds, from 0·03mm to 2mm per revolution.

The optical system of the table and the saddle is based on a glass scale, the millimetre divisions of which are projected along with a scale and magnified one hundred times so that an actual movement of the table or saddle of 0·01mm is shown on the scale as 1mm. Thus, it is stated, the movements of the table and saddle can be made to within limits of 0·005mm and a working accuracy of plus or minus 0·01mm is easily obtained.

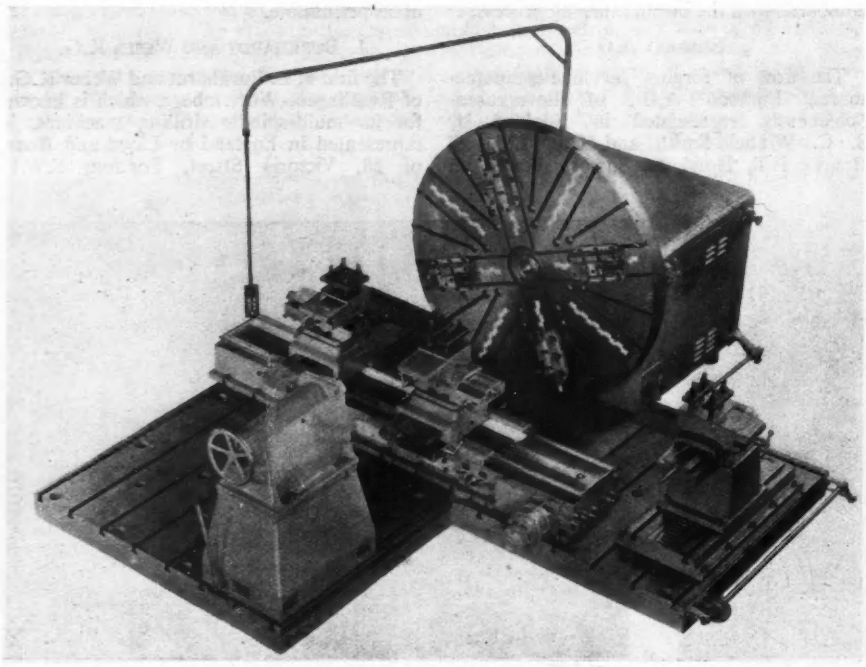


Fig. 22—Large Facing Lathe—Heyligenstaedt

Institution of Naval Architects

AUTUMN MEETING

No. IV—(*Concluded from page 559, October 24th*)

THE final technical session of the Autumn Meeting of the Institution of Naval Architects, which was held jointly with the A.T.E.N.A., at the Consiglio Nazionale delle Ricerche (National Research Council), Piazzale delle Scienze, in Rome, took place on Monday, September 29th. Viscount Runciman, the president of the I.N.A., presided.

The discussion on the first paper was reported in our last issue. The second paper presented on Monday morning was :—

PRINCIPAL CHARACTERISTICS OF WARSHIP DESIGN

By Dr.-Ing. Professor A. Servello

Synopsis

The formulation of approximate rules for guidance in warship design presents many practical difficulties due to a number of causes. In this paper, it is deduced that the principal dimensions of a warship can be obtained in all cases by the naval architect at the beginning of his task by using statistics available from world-wide sources.

The displacement should be obtained from the displacement equation, then the length on the water line, the breadth and jointly the draught and block coefficient. Any departure which is considered essential for practical reasons, from the values obtained, should only be made after careful examination of the specified requirements for the ship being designed. The displacement/length ratio of various warships plotted against speed is shown graphically and a table gives corresponding dimensions of merchant ships having the same speed and displacement of a battleship, a destroyer and a cruiser. Formulæ are developed for obtaining length, breadth, draught and the block coefficient.

Discussion

Dr. Marsich : The best warship is that which, for a given endurance, needs the least power, the other factors being armament, protection and speed.

The displacement is concerned strictly with the length and weight of the ship, which are the elements necessary to the preparation of the displacement equation, and this is followed by fixing the block coefficient.

Next, the midship section area and coefficient are decided upon after taking some account of the power of the ship and after satisfying conditions linked by the transverse stability requirements of the ship. These can be determined by a family of curves which give the stability characteristics as functions of the draught and beam.

That is the way to prepare a design, and not by using stability as a basis, which is not the fundamental element, but something which is determined after the other characteristics are decided. In this way the prismatic coefficient can be determined, taking account particularly of the power of the ship, because the coefficient is the most important item affecting the resistance and hence the power output.

Professor E. V. Telfer : I am sure that the author intended to discuss the principal form coefficients of ships and not the principal characteristics of design, therefore it might be better if the title could be changed, so that students studying these matters in the future will not be misled.

I am surprised that the author is using a displacement/length coefficient which goes back to an interesting set of papers dealing with ship resistance published in 1893, before the North-East Coast Institution by Hök. That particular displacement / length coefficient was then adopted by Taylor and has been used also by the American tank consistently ever since. I have been impressed by the way in which our Italian colleagues always stuck to the Froude constants, and much of the author's work would have been greatly simplified if he had used the Froude M value instead of the displacement/length value. The latter is an inverted form of coefficient and it leads to reversed thinking. The inverted presentation has led the author to quite unnecessary difficulties in arranging his statistical matter.

About his treatment of the wetted surface, using the Denny formula, this particular formula was given by Mumford in 1892 before the I.N.A. Mumford set out by analysing a systematic series of models to deduce a correction in the Hök coefficient, and he eventually found the value of 1·7. Nearly thirty years ago I was investigating Mumford's work and I showed that the Mumford formula could be generalised.

The point is that the 1·7 is not a constant, but depends on the value for the block coefficient. And as the author has derived a certain line of argument depending on the ratio of the side area to the bottom area, his argument requires qualification as between various block coefficients. The wetted surface is always a minimum when the side area equals the bottom area, and I should like him to consider what effect on his own conclusions this particular work of mine may have.

Mr. V. G. Shepheard (written contribution to the discussion, read by Mr. Gawn): The paper gives some idea of the broad trend of change of the principal dimensions of ships of different classes, in relation to the displacement and full speed. The spots for individual ships on the various diagrams are generally scattered over a wide field, and this emphasises that the designer cannot expect any real guidance from the statistics in the paper.

The author mentions that individual ships have special requirements, but it must not be overlooked that one or two fundamental aspects should be considered. Two illustrations deal with the change of length relative to full speed and displacement, this is acceptable for merchant ships, but endurance at cruising speed is important for warships and is reflected in the design characteristics. Design is governed by the space and weight of machinery, armament, equipment and accommodation, involving a good deal of compromise. The part played by strength considerations and by manœuvring and seaworthiness qualities have been neglected in the paper.

One of the features of ships is the growth of relative beam and perhaps the author could indicate whether the chronological trend is supported by his analysis.

The only diagram in which the spots for individual ships are close to a mean curve indicates the reasonable validity of approximate formulæ for the area of the wetted surface of a ship. The parameters on this diagram are the significant terms of R. E. Froude's simple expression for the wetted surface. The author's confirmation that length and displacement are the dominating characteristics for the determination of surface area is of interest.

Mr. J. A. Milne: The author uses a mixture of metres and knots in his $\frac{V}{\sqrt{L}}$ proportions. I should like to see that altered either to metres or knots and feet, since it is frightening when one hears of the value of $\frac{V}{\sqrt{L}}$ given as more than 3·5. I endorse what Professor Telfer said about the English title of the paper, and suggest "Principal Characteristics of Warship Hull Form."

Professor Servello, in his reply, said: I do not presume to state that the method put forward in the paper is the only way in which to prepare the design of a warship, but I want to find a way to prepare the design of a ship. When the designer has found the dimensions by this method he has not achieved the perfect design, but has then to compromise on all the elements which enter into the design, the method having given him a starting point.

The final paper read at the meeting in Rome was :—

AN INVESTIGATION INTO THE MOTIONS OF SHIPS AT SEA

By A. J. Williams, R.C.N.C.

Synopsis

During recent years a number of sea trials have been carried out by the Admiralty to obtain data for use in the design of stabilisation systems. This paper describes, in general terms, the trials carried out in H.M. Ships "Vengeance," "St. Kitts," "Cygnet" and "Cumberland," and discusses the problem of instrumentation linked with a description of the instruments used. Some interim results of the analysis of the records obtained from these trials are given, with particular reference to rolling, typical curves of rolling and pitching being reproduced. It is shown that under confused sea conditions, the predominant rolling period is the appropriate still water period and a statistical law governing the frequency of occurrence of roll amplitudes of various magnitudes is suggested. Some notes are included upon the analysis of curves of declining angles including a graph showing curves of magnification factor, which give a qualitative picture of the effect of damping and indicate that a ship is a finely-tuned oscillating system. The paper concludes with some general remarks on the nature of pitching and states that the results of model tests have been generally borne out by the evidence from sea trials.

Discussion

Professor G. Rabbeno: In 1935 I presented to the Association Technique Maritime et Aeronautique a memorandum on "The Stabilisation of Ships in Waves," and drew attention to the fact that the greatest discomfort to passengers on account of extensive rolling is due to tangential acceleration.

Professor A. Servello suggests that we assume the value of the maximum transverse tangential acceleration at the level of the highest part of the superstructure as a measure of the rolling fatigue on waves. Consequently, numerical values of that acceleration can be fixed for the various types of merchant ships, from which values the determination of the most suitable GM for each case is then deduced.

The modern tendency in American naval construction is towards limits never assumed before, the initial metacentric height of the passenger ships at the beginning of the trip reaching about one-twentieth of the ship's breadth.

To reduce the effects of high values of the tangential acceleration on existing passenger ships it will be necessary to close successively the highest bridges of the superstructures to the passengers as soon as the sea conditions become heavier, and to counter this, water ballast tanks at a high level should be provided.

Professor A. M. Robb: I welcome Mr. Williams' attitude, because recently an elaborate paper on rolling was presented to a sister Institution, in which the authors, by mathematics, claim to tell whether a ship is safe from capsizing. Just afterwards, the "Flying Enterprise" circumstance arose, and I suggest that that knocked the bottom out of the whole of their mathematics.

I am doubtful whether at the moment we need to go any further with our mathematics than the simple addition to the classic Froude theory of a term with the resistance varying as the velocity only.

I join issue with Mr. Williams, where he says that unfortunately, the damping is not proportional to angular velocity alone, but also includes a term in the square of the angular velocity, which introduced the term $b\dot{\theta}^2$ into the extinction. I thought that that old expression had been killed by Mr. John Bain in 1934 and Mr. John in 1940. They have shown that it is just not valid. We are compelled, as a practical measure, to accept and adopt the assumption that the resistance varies as the angular velocity alone. It is not correct, but it is near enough to the truth. The important thing is that the ship will roll heavily only when she meets waves in about her own natural period and the other thing is the position of the ship at maximum angle on the wave. Those are the two important elements, from the theory, and I am sorry that in this experimental investigation we have no data on the wave slope. It is no use checking the mathematical expression unless you can relate the wave slope to the maximum angle.

Professor Sir Thomas H. Havelock, F.R.S.: In section 5 of the paper there is an interesting attempt to apply a statistical formula to the probable amplitude of rolling in a random sea. I presume that the definition of a completely random sea would be some kind of mathematical specification such as is given in the appendix. I imagine the completely random sea is a convenient mathematical fiction, just as the completely regular sea. As this work shows, the motion of the sea has underlying regularities with random perturbations superposed; and there is a corresponding response in the motions of the ship, depending upon the characteristics of its natural oscillations.

Turning to the general conclusions, from (i) it would appear as if forced rolling did not occur. This conclusion must be taken as subject to the conditions under which the observations were made. If there were regular waves which would have produced forced rolling, then the ship's course was such—or was altered to be such—that it was not allowed to develop.

In pitching (vi), the amplitude of the forced pitching varies in a cyclical manner, suggesting interference by a second period; this is supposed to be due to superimposed free pitching constantly regenerated by the irregularity of the sea. If we think only in terms of the simple linear theory of pitching, this is the only other period at our disposal. However, in view of the heavy damping of free pitching, it is difficult to see how it is maintained with sufficient regularity to give the observed effect. The same phenomenon occurs with models in a tank, where the waves are presumably smooth and regular. No doubt the cyclical variation of amplitude is more regular in a tank than in the open sea, but it seems to have the same effect and one looks for a common cause. The present simple theory of pitching is inadequate for motions of large amplitude, even in regular waves.

Another point, not referred to in the paper, is the possible coupling of the natural oscillations. I like the analogy of the ship as a filter tuned to a certain selective frequency. There are three selective frequencies; and further, heaving, pitching and rolling are not in general independent, but are coupled. Coupling has usually been assumed to be small and has been neglected, but it must be taken into account for motions of large amplitude; and I imagine the effects might be quite important for motion in a rough sea, especially for heaving and pitching. In this connection I ask if records were taken of heaving; or could this motion be deduced from records taken during pitching?

Mr. V. G. Shepheard (a written communication read by Mr. Gawn): Ship designers have always regarded information on the motion of ships in seaways as fundamental to their art and have regretted that knowledge on this subject was limited by the measurements they could make and the accuracy with which they could be taken. Recent years have seen great strides in instrumentation techniques, and we now have available means of recording the motions of a ship more completely and accurately than ever before. There are still some components of the motion which are not so fully and so accurately covered and it has not been found possible to record the characteristics of the sea which are the cause of the ships' motion.

This advance in our ability to record and study the fundamentals of ship motions comes at an opportune time, because with

present-day stabilising equipment this knowledge can be turned to practical account both by the designer of a liner to increase the comfort of the passengers and by the designer of a warship to make her a better fighting platform.

Experimental evidence is costly to obtain and occupies a great deal of time ; however, soon we shall have available a number of statistical instruments which will supply useful information without the necessity for the continuous presence of specialist scientific teams. Advances in our knowledge could be expedited and the need for costly trials with ships at sea reduced if more facilities were available for model experiments. They afford a good investment for any organisation interested either in reducing ship motion or in a more complete knowledge of its characteristics.

The author's conclusions that when the ship is rolling heavily the motion is very nearly simple harmonic and that as the amplitude of roll increases its period tends to a unique value approximating to the still water rolling period are of great significance, and will be searchingly studied by those concerned with stabilisation problems.

Mr. R. W. L. Gawn : We have had some valuable papers dealing with the oscillation of ship models in regular waves, but the author's work gains in importance in that it concerns actual ships at sea, whether they be random or otherwise. It is instructive to examine the extent to which the lessons learned from model tests and theory are borne out by sea experience. The conditions in the violent storm which " Cygnet " weathered appear to approximate to that of seas with some approach to regularity of a length greater than that of the ship and unusually steep. The approximate amplitude of pitch of plus or minus 12 deg. is equivalent roughly to about 70 per cent of the maximum slope of the surface waves. The period of pitch quoted by the author is 7½ seconds, which may be regarded as equal to the period of encounter, for this is estimated as 8 seconds for the length of wave and speed of ship. Both the amplitude and the period accord with expectations from model tests generally. Although the amplitude of pitch is large, model experiments indicate that had the seas been longer, even greater amplitudes, commensurate with the wave slope, may have been reached. That that is so may be appreciated from the report that the bow of the " Ark Royal " moved vertically 56ft up and down during the hunt for the " Bismarck " in the last war, and making some allowance for heaving, this indicates pitching amplitudes comparable with the wave slope.

Again, the maximum amplitude of rolling occurs according to model tests and theory at synchronism. It is instructive to have confirmation from the trials that this also obtains in heavy weather in the complex seas. Another and more subtle agreement between model and ship is the author's difficulty in obtaining unique values of the *a* and *b* coefficients in the extinction equation for still water rolling. He has evolved an attractive method for determining the coefficients, but experience with model tests has shown that the assumption of a parabolic law for the extinction equation is no more than a reasonable approximation, with all the consequences both statistical and physical, including difficulty in determining unique values for *a* and *b*. The author's comment on this would be appreciated.

Issue is joined with the author in attributing the co-periodicity of pitch in regular waves with the period of encounter explicitly to the heavy damping of this motion. Rolling in regular waves also occurs in the period of encounter. This is generally true even when bilge keels are removed from the model and the damping is comparatively light. If, however, the model is initially inclined, then the rolling is that of the free period in shorter waves, but the wave period is followed in longer waves, depending on the relative amplitude of the free and the forced oscillation. Some results confirming this are contained in a paper by Mr. M. P. Payne in our 1924 *Transactions*. The results in this paper also show that the dominant period of rolling in non-uniform waves is that of the model.

A further point in this connection is in the statement that damping in pitch is much heavier than in roll. This statement, unless qualified, may give an exaggerated impression of pitch damping. For example, curves can be drawn additional to those shown (magnification factor) for higher values of the damping coefficient, and it will be found that response curves reasonably commensurate with those obtained in pitch with a maximum amplitude ratio of unity are obtained for values of the damping coefficient no greater than about four or five times those for rolling.

Dr. J. F. Allan : In conclusion (i) it is stated that the period of rolling of a ship in heavy weather tends to be that of the natural rolling period ; and no doubt that is well known. But in conclusion (vi) it is stated that the period of pitching in a seaway approximates to the predominant period of encounter. I think the period of roll and the period of pitch is, in general, a forced period, and if there is heavy pitching or heavy rolling, it will be at about the natural period of pitching or rolling. But where there appears to be a difference in the sensivity of a ship to tuning, as regards rolling, the sensivity to the tuning factor is much more sharp than in pitching,; so that in pitching you get this rising and falling effect up to a maximum and down to a minimum, spreading over a wider range than in rolling.

The formula given in conclusion (ii) has a very limited validity ; I have checked it against some merchant ship data and it does not fit that data at all well. That does not detract, however, from its value in relation to the ships to which Mr. Williams refers.

Indian Metre Gauge Locomotives

THE first of 100 4–6–2 " YP "-class locomotives being built for Indian Railways was delivered in June last by the North British Locomotive Company, Ltd., Springburn, Glasgow. These Indian metre-gauge locomotives are intended for passenger train operation and are built to the design and requirements of the Central Standards Office of the Ministry of Railways, Chittaranjan, and under the supervision of the consulting engineers, Rendel, Palmer and Tritton.

One of the new engines is illustrated on this page, and the leading particulars are given in the table.

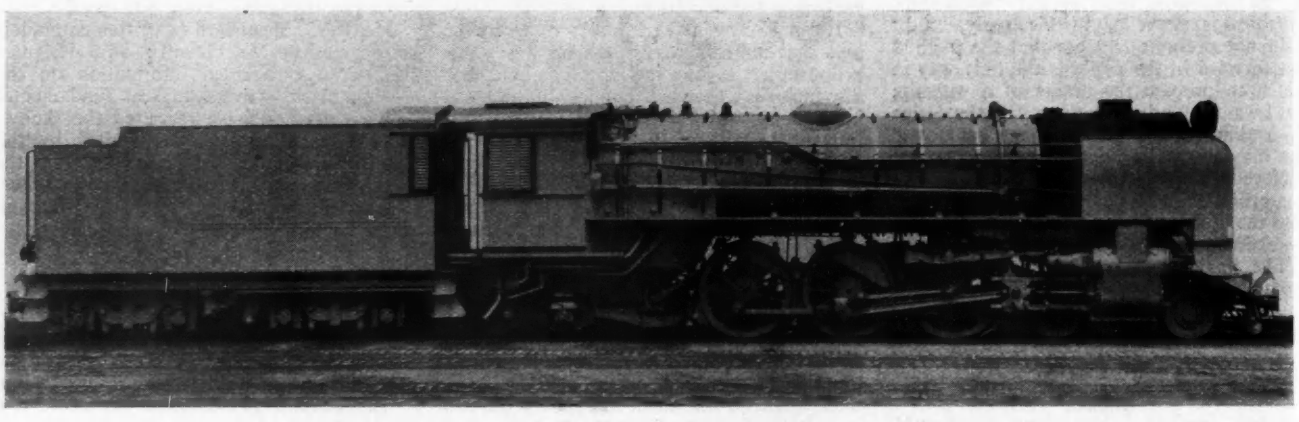
The boiler barrel consists of two rings, the first of which is tapered, and the external diameters at front and rear are 4ft 9in and 5ft 2in, respectively. The longitudinal seams are treble riveted with inside and outside butt strops, and the circumferential seams are double riveted. The distance between the tubeplates is 12ft 10¾in, and there are sixty-seven boiler tubes of 2in outside diameter and twenty-six superheater flue tubes of 5¼in outside diameter. The smokebox tubeplate is attached to the boiler barrel by means of a solid-rolled angle ring.

An inner steel firebox, of all-welded construction, incorporates a thermic syphon and two arch tubes, and is stayed to the roof of the round top outer firebox by direct steel stays with four rows of flexible stays at the front. Flexible waterspace stays are also fitted at the combustion chamber and sides and back of the firebox in the breaking zones.

A twenty-six element " Melesco " superheater is fitted and the header is provided with an anti-vacuum valve. A " Joco " regulator, situated in the dome, is operated by a " Ramshorn " handle fitted in the cab.

The general steam fittings include two I.R.S. pattern injectors, three 2½in Ross pop safety valves, two sets of water gauges with protectors and two Evrit blow-off cocks.

The main frames of the engine, which are finished to a thickness of 3½in, are cut from rolled



4–6–2 Indian Metre Gauge Locomotive

steel slabs and are stayed by cast steel cross-stretchers. The hind end of the frame consists of a one-piece cradle steel casting securely attached to the rear of the bar frames by turned and fitted bolts. Coupled axleboxes of bronze are equipped with "Ajax" keeps and grease lubricators.

Laminated bearing springs fitted throughout the locomotive are overhung with compensation arranged between the leading coupled and trailing truck wheels. To keep the weight of the locomotive within the stipulated maximum, the engine platforms and cab are built of aluminium plates and sections. The automatic couplers at the front of the engine and the rear of the tender are of ABC/PH type.

Locomotive Details

Cylinders, diameter	15½in
Piston, stroke	24in
Coupled wheels, diameter	4ft 6in
Engine bogie wheels, diameter	2ft 4½in
Engine truck wheels, diameter	2ft 4½in
Engine coupled wheelbase	10ft
Engine total wheelbase	29ft 9in
Heating surface :	
Large tubes	459 square feet
Small tubes	456 square feet
Firebox, including syphon and arch tubes	196 square feet
Total	1111 square feet
Superheater	331 square feet
Total	1442 square feet
Grate area	28 square feet
Working pressure	210 lb per square inch
Tank capacity	3000 gallons
Fuel (coal)	9·5 tons
Tender bogie wheels, diameter	2ft 4½in
Total wheelbase, engine and tender	53ft 7in
Weight in working order :	
Engine	57 tons 3 cwt
Tender	41 tons 1 cwt, 2 qr
Engine and tender, total	98 tons 4 cwt, 2 qr
Tractive effort at 85 per cent working pressure	18,450 lb

The cast iron cylinders are provided with renewable liners in the barrels, the cylinder and steam chest hind covers being steel castings and the front covers cast iron. Walschaerts valve gear actuates 9in diameter piston valves, which have a travel of 7in. Skefko roller bearings are fitted to the crank ends of the eccentric rods and hand-screw reversing gear is fitted.

The engine front bogie and hind truck are equipped with Timken roller bearing axleboxes, those for the bogie being of split cannon design. Vacuum brake equipment is provided for engine and tender and actuates brake blocks on all coupled and tender wheels. Its fittings include an "SJ" type "P" ejector; two "F" class cylinders, one 15in and one 21in on the engine, and two 15in cylinders on the tender. The gravity dry sanding equipment fitted delivers sand in front of the leading coupled wheels.

Stone's electric lighting equipment is installed, and includes a "T.G.1" turbo-generator, a "Tonum E" headlight and all necessary cab and gauge lights. A B.T.H. speed indicator is also fitted.

The double four-wheel bogie tender carries 3000 gallons of water and 9½ tons of coal, and its tank and bunker are of welded construction throughout. The tender underframe is built up of longitudinal channels and cross-sections welded together, with cast steel dragboxes at front and rear. The tender bogie side frames consist of flanged plates welded together to form a box section. This design was originally evolved for the tender bogie frames of the Indian "WG" locomotives, which were built recently by the company, and it obviates the need of large steel castings. Skefko roller bearing axleboxes are fitted on the tender bogies.

Opening of the Claerwen Dam

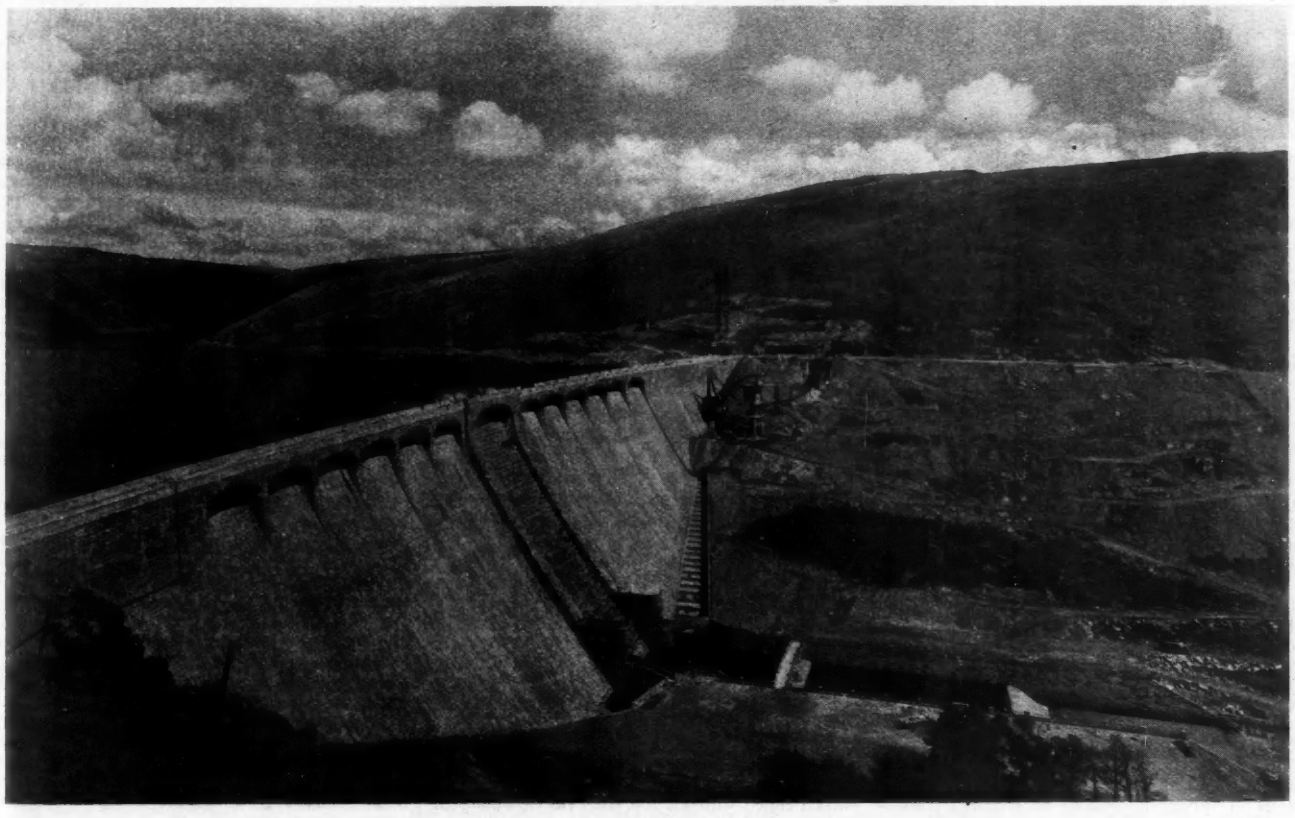
ON Thursday, October 23rd, Her Majesty, the Queen, opened the Claerwen dam, which is situated in Wales, near the village of Rhayader, in the catchment of the River Elan. This event brings to a successful conclusion a project which has been under construction since 1946. The dam forms part of the supply system of the City of Birmingham Water Department, and water stored in the reservoir will be released, as required, to flow down the original course of the Claerwen to other reservoirs of the Elan valley system, before passing into the aqueduct to Birmingham.

An account of the dam and its relation to the other reservoirs of the system was given in THE ENGINEER of December 6, 1946, and since that date several descriptions of the progress of the project have appeared in these columns (in July 8, 1949, and as part of the annual reviews of civil engineering works published in January of each year). Only one or two leading particulars of the dam will, therefore, be given here. As may be observed from the accompanying illustration, it is a mass concrete gravity structure faced with masonry on the downstream face, and the upper part of the upstream face (up to 40ft below the crest the upstream side is faced with Staffordshire brindle brick). The maximum height of the dam from foundation to roadway level is 240ft; the height from the stream bed to the crest is 184·5ft, the overall length 1120ft, and the total volume of concrete contained in it is about 380,000 cubic yards. It is thus the largest dam in the British Isles.

A roadway is carried across the crest of the dam, spanning the 520ft spillweir on thirteen arches, twelve of 40ft span and the central one of 60ft. Side spillweir channels extend for the full length of the spillweir, falling towards the central channel which extends downstream of the dam for 360ft, roughly in the stream bed, ending in a baffle and measuring weir. Draw-off and scour pipes are accommodated in the dam.

The reservoir has a capacity of 10,625 million gallons (nearly 245,000 acre-feet). Its effect upon the supply available at any time may be judged from the fact that the remaining reservoirs of the system have a combined capacity of 11,175 million gallons, which has been estimated to give a maximum assured yield of 72 m.g.d., of which 27 m.g.d. are for compensation water and 45 m.g.d. for supply.

The City of Birmingham Water Department's consulting engineers for the Claerwen dam are Sir William Halcrow and Partners, and the main contractor is Edmund Nuttall, Sons and Co. (London), Ltd.

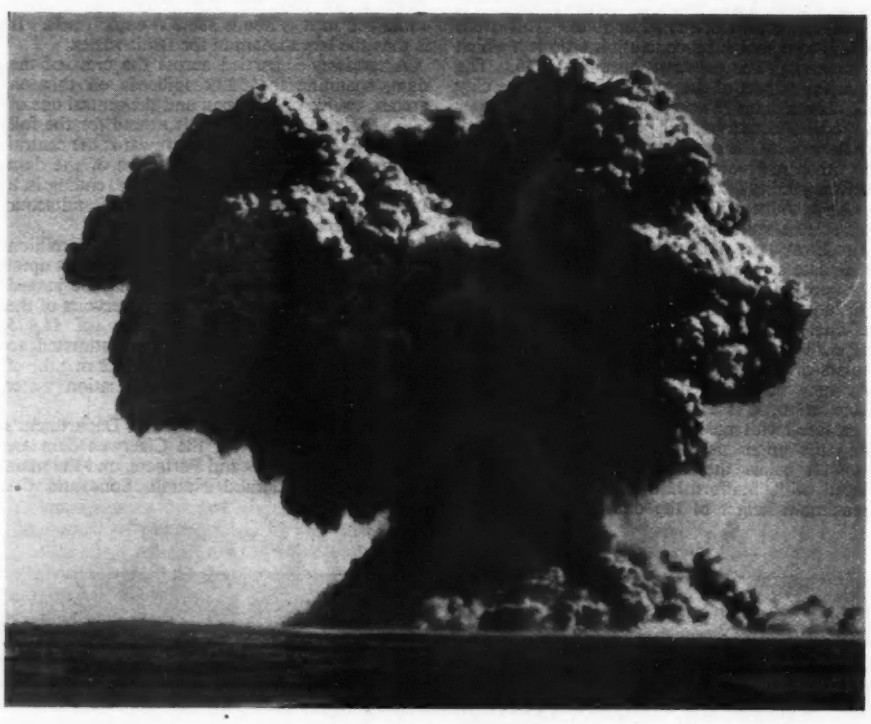


Claerwen Dam

The Monte Bello Atomic Tests

CERTAIN details of the combined operations undertaken by the Governments of the United Kingdom and Australia in preparation for the recent atomic weapon tests at the Monte Bello Islands have now been disclosed by the Ministry of Supply. The Royal Navy, the Army, the R.A.F., the Royal Australian Navy, the Royal Australian Air Force, the Australian Defence Department, the Commonwealth Meteorological Research in Melbourne and the Australian Security Intelligence Organisation, all played a part in these operations.

About two years ago the Royal Navy, through its Deputy Chief of Naval Staff, Vice-Admiral E. N. Evans-Lombe, C.B., was asked to start preparing for the operation. A committee was formed and Rear-Admiral A. D. Torlesse, who was to be in command at the Monte Bellos, was called in to help prepare the detailed plans. The problem of finding a suitable site for the test was resolved when, with the permission and assistance of the Australian Government, the Monte Bello Islands were chosen.



Early Stage of the Explosion

Scientific aspects of the experiment were directed by Dr. W. G. Penney, of the Ministry of Supply, who had as his deputy Dr. L. C. Tyte, also of the Ministry of Supply. Those taking part included Mr. W. A. S. Butement, Chief Scientist, Commonwealth Department of Supply and Development; Professor L. H. Martin, of Melbourne University, Chairman of the Australian Defence Scientific Committee; Dr. E. W. Titterton, Australian National University, and Dr. O. M. Solandt, Chairman, Canadian Defence Committee.

The Ministry of Works, which was responsible for a great deal of constructional work, and the Home Office, were closely concerned with civil defence aspects of the test. Much work was also undertaken by, and on behalf of, the Medical Research Council, whose advice was of great value.

The Royal Navy had as its main task transport, housing and logistic support of the expedition. This work involved provision of a base ship ("Campania"), three L.S.T.s and the "weapon ship" ("Plym"). Nearly all required conversion to suit them for their special tasks.

The L.S.T.s, two of which were specially fitted to perform important scientific tasks in the test, carried our Army component of about 200 Royal Engineers and all the stores. They also carried the minor landing craft (twelve L.C.A.s and five L.C.M.s) and their Royal Marine crews. The Royal Marines were responsible for running and maintaining these craft.

"Campania" carried a naval flight of five aircraft in all.

The Royal Engineer detachment, carried on the troop decks of two of the landing ships, planned and carried out civil engineering work ashore to meet the requirements of the Ministry of Supply.

Besides providing a small number of personnel for direct participation in the test, and three doctors for radiological medical work, the Royal Air Force provided air transport for personnel and material between the United Kingdom and Australia.

The Islands

The Monte Bello Islands consist of a group of about 100 small islands, the largest of which are Hermite, Trimouille, North West and Alpha Islands.

There was no water supply of any sort nor any building except two ruined huts. Everything required had to be brought to the islands either direct from the United Kingdom or from the nearest supply base at Fremantle, 900 miles away to the southward.

The programme for refitting and commissioning of ships and the dates of departure from the United Kingdom and arrival at the site were settled as early as August, 1951, and were adhered to almost exactly.

The advance party, consisting of H.M.S. "Zeebrugge" and H. M. S. "Narvik," under the command of Captain G. C. Colville, O.B.E., R.N., departed from Portsmouth on February 19, 1952, and arrived at the Monte Bello Islands on April 26th.

The three ships, "Campania," "Tracker" and "Plym," arrived at the islands on August 8th, and commenced the installation period, which ended with the test itself on October 3rd, exactly eight weeks later.

Royal Australian Air Force participation included the basing of seven "Lincoln" aircraft at a camp specially constructed at Broome Civil Airport.

Besides the five ships of the Royal Navy the test took place in the presence of eleven ships of the Royal Australian Navy, while the leading scientists present included the three Australians previously mentioned.

A close patrol over a wide stretch of sea was maintained to ensure continuous daylight reconnaissance from September 1st onwards. From the time that the other ships of the Australian Fleet arrived until the time of the explosion of the weapon, they kept up a day and night patrol.

The actual explosion of the atomic weapon was referred to in a statement by the Prime Minister, the Rt. Hon. Winston S. Churchill, in the House of Commons on Thursday, October 23. Mr. Churchill explained that the object of the test was to investigate the effects of an atomic explosion in a harbour and, accordingly, the weapon was detonated in H.M.S. "Plym," a frigate of 1450 tons. The weapon behaved as was forecast in many precise details by Dr. W. G. Penney and the results showed, Mr. Churchill continued, that the "weapon does not contradict the natural expectation that progress in this sphere would be continual." Thousands of tons of water and sea-bed deposits were thrown many thousands of feet into the air and a high tidal wave was caused. The effects of blast and radio-activity were widespread. Very soon after the explosion water samples were taken from the heavily contaminated lagoon by helicopters. Later other personnel entered the zone to recover records.

When the flash first burst through the hull of the frigate the temperature was nearly 1,000,000 deg. The vessel itself was vaporised with the exception of some fragments which started scattered fires in the vegetation on one of the islands. The expedition suffered no casualties and animals were not used. When asked whether any new scientific knowledge had emerged in connection with atomic weapons or of industrial applications of atomic energy, Mr. Churchill said that he had carefully considered the terms of the statement and he did not wish to add to them.

Re-entry to the islands is now in progress and the task of recovering records and salvage will take several weeks. Elaborate arrangements have been made to obviate the danger to personnel through radioactive contamination.

A Ship-to-Shore Television Experiment

RECENTLY, the B.B.C., in collaboration with the Southern Region of British Railways, began experiments to explore the possibility of obtaining television pictures from a cross-channel steamer on the Dover-Boulogne service.

One of the mobile transmitters of the Television Outside Broadcast fleet put to sea in the Southern Region's motor-car ferry, the "Lord Warden," and transmitted special signals to a receiver mounted on the R.A.F. radar tower at Swingate, near Dover. No cameras were taken on board the "Lord Warden" for these initial tests, but the strength of the signal received at Swingate was measured there, and any interference was observed at the same time.

The combined power-transmitter-aerial vehicle was run aboard the Dover-Dunkirk train ferry and landed at Dunkirk.

The transmitter was operated in the 190 Mc/s band with an output of 340W. A special directional aerial of the Yagi type was used at the top of the 100ft extending ladder with which the vehicle is equipped. Transmissions were started from the "Lord Warden" on Thursday, October 16th, some 3½ miles outside Boulogne, and reasonably satisfactory signals were received at Swingate during the entire journey to Dover, although a certain amount of interference from other transmitting stations was experienced. Further tests were carried out on Friday, October 17th, during both the outward and homeward crossings, and these tests indicate that there should be no serious obstacle to the transmission of satisfactory pictures next spring, when it is proposed to transmit programmes from the "Lord Warden."

Design and Operation of Dunston "B" Generating Station*

By A. HOWELL, M.I.Mech.E., M.I.E.E.,† and J. B. JACKSON, M.I.Mech.E., M.I.E.E.‡

No. I—Design

Two 50-MW turbo-alternators unitised with reheater boilers were commissioned at Dunston "B" generating station towards the end of 1950, and ranked as the most efficient generating plant owned by the British Electricity Authority during 1951.

Part I of the paper discusses the changes in design compared with the original plant. In Part II, plant staffing and staff training are discussed and details of operating experience are given, including the procedure evolved for starting-up and shutting-down. Performance and "outage" figures for 1951 are analysed.

The Dunston station was laid out for 300MW in six 50MW units using the reheat principle which had been employed by the North Eastern Electric Supply Company for the first time at its North Tees station in 1921, but now employing higher pressure and temperature and larger turbines. Three of these were installed initially, to constitute the largest of the company's four main power stations, which together supplied an area of 5500 square miles. A further machine was added in 1939.

The pressure adopted, 600 lb per square inch, was then considered to be the most economical with the prevailing price of coal. The boilers were relatively small, each turbo-alternator being supplied by four units in a transverse line, and reheaters being incorporated in the two boilers nearest to each turbine to shorten and cheapen the reheat pipework; the evaporating capacity of the other two was so chosen as to give the same maximum fuel consumption in all four boilers, thereby permitting the use of the same coal-burning equipment. The first eight were stoker-fired, but the next four, in a separate boiler-house, later to contain the four associated with the fourth turbine, were fired with pulverised fuel, largely to utilise the dust from the coal-cleaning plant then being installed by some of the company's colliery consumers. The boiler groups were interconnected through the high-pressure steam pipework, but not on the reheat level, two reheaters being permanently associated with each turbine.

The turbines were arranged in line in a turbine house which, like the boiler-house, attracted some attention, owing to the exclusive use of glass instead of bricks for clothing the steel frame; a proposal that sprang not from æsthetic considerations but from its relative cheapness and from its contribution to the great speed with which the building was enclosed. The completed buildings now contain 5¼ acres of glass.

The river Tyne was used for cooling, and the original pump-house, which had to be constructed behind a cofferdam, was made large enough for the ultimate capacity, the allowance being one pump for each of the six machines, interconnected on the discharge side; the circulating water system is common to the whole station.

When, in 1945, the company decided to proceed with the installation of the last two machines, certain modifications were introduced which had been made possible by technical developments in the intervening years or which seemed desirable as the result of the accumulating operating experience. The most important of these was the adoption of "unitised" operation, whereby one turbine was to be associated independently in normal service with one large boiler; a proposal that seemed attractive as effecting savings both in capital and in operating charges. This choice would normally have left a free hand in the selection of the steam cycle to be used for the new units, but a combination of circumstances made it advantageous to adhere to the main steam pressure already in use, in order to provide for partial interconnection with the existing plant on the high-pressure side for use during certain stages of construction and during the progress of certain projected works in the existing station. The temperatures of both the main steam and reheat steam were, however, raised by 50 deg. to 850 deg. Fah. at the turbine valves, thus giving an estimated efficiency approximating to that of the present national standard plant of 900 lb 900 deg. Fah.

Other changes made are summarised in Tables I and II.

Turbines

The change from a speed of 1500 r.p.m. to 3000 r.p.m., which produced a less bulky turbo-alternator, brought with it certain consequential changes, in particular, the use of three cylinders in place of two and the necessity for two exhausts instead of one. The design of the high-pressure cylinder was simplified by having no overload by-pass, so that the most economical rating now became the maximum continuous rating of 50MW instead of 80 per cent of this as in the older machines. As the two machines were to form a relatively small part of the total generating capacity, there seemed some prospect of ensuring an operating programme sufficiently favourable to take advantage of this feature. Steam was abstracted for reheating at 151 lb per square inch at continuous maximum rating, corresponding to the previous pressure at this rating.

The feed-heating system was arranged schematically as before, except that no unit evaporator was provided (nor a central evaporator), as the operation of the older plant had shown that the make-up could be kept well below the capacity there provided, thus making available spare capacity for the use of the new plant.

It was decided to drive the main oil pump for each of the new machines not from the high-pressure shaft, as on the older machines, but by a separate a.c. motor. This seemed to have sufficient advantage (as, for example, in reduction of fire risk by removing the main oil system farther away from the steam end) to make the experiment worth trying; the arguments against the arrangement were known in principle, but seemed insufficiently conclusive without actual experience. A steam-driven pump is provided in addition and brought into service automatically, either by failure of electrical supply at the motor of the main oil pump or by loss of oil pressure. The operating pressure is 20 lb per square inch for bearing lubrication and 70 lb per square inch for governor control.

The governing and protective devices are generally similar to the existing arrangements, there being, however, only one high-pressure governor valve in addition to the combined emergency and stop valve, both operating in a single steam chest separated from the cylinder. The high-pressure governor, as before, is on a cross-shaft driven from the high-pressure shaft. The intermediate-pressure governor, however, is now mounted on the opposite end of the same cross-shaft instead of being driven from the low-pressure shaft as in the older machines. This governor normally keeps fully open the two governor valves in the steam chests on either side of the intermediate-pressure inlet, but begins to close them on a rise in speed; a suitable margin—originally 4 to 5 per cent—above normal speed being allowed before this governor commences to act, in order to prevent the intermediate-pressure valves from interfering with the normal governing of the machine and, on loss of load, to give the high-pressure governor the opportunity to close first and thus avoid a pressure rise at the high-pressure exhaust. A relief valve on the pipe to the reheater inlet takes care of any rise that might still occur due to malfunctioning of the governors, and, if the relief valve also should fail, a pressure trip on the exhaust pipe, set somewhat higher than the relief valve, closes the high-pressure emergency valve and both the high-pressure and intermediate-pressure governor valves. The intermediate-pressure governor valves can be lifted mechanically when vacuum is being raised, to enable the high-pressure turbine, reheater, and interconnecting pipework to be evacuated before oil pressure is available. The mechanical gear falls out of operation when the valve lifts under oil pressure. Of the two emergency trip-bolts at

TABLE I—*Essential Differences in Design of Nos. 1–4 Turbo-Alternator Sets and Nos. 5 and 6 Sets and Associated Auxiliaries*

	Sets 1 to 4	Sets 5 and 6
Output per machine	50MW continuous maximum rating : 40MW economic rating	50MW continuous maximum and economic rating
Speed	1500 r.p.m.	3000 r.p.m.
Number of cylinders	Two	Three
Number of low-pressure exhausts	One	Two
Steam conditions : Pressure	600 lb per square inch gauge	600 lb per square inch gauge
Temperature	800 deg. Fah.	850 deg. Fah.
Reheat pressure	151 lb per square inch gauge at C.M.R. / 115 lb per square inch gauge at economic output	151 lb per square inch gauge at economic C.M.R. / 119 lb per square inch gauge at 80 per cent load
Reheat temperature	800 deg. Fah.	850 deg. Fah.
Normal vacuum conditions	29in of mercury at 40MW	28·75in of mercury at 50MW
Feed pump discharge pressure	850 lb per square inch guage	890 lb per square inch gauge
System of operation	Range system	Unit system
Evaporators for producing make-up feed-water	Unit evaporators plus a central evaporator	No more required
Type of main oil pump	Gear-driven from main high-pressure turbine shaft	Separately driven by an a.c. electric motor
Voltage of generation	13·5kV	11kV
Exciters	Direct-driven from alternator rotor shaft, shunt excited	Combined main and pilot exciters separately motor driven
Alternator cooling fans	Two 80 per cent capacity fans for each set between the air cooler and the air inlet to the machine	One full capacity fan for each set driven by the same motor which drives the main and pilot exciters. The fan is between the machine air outlet and the cooler

TABLE II—*Leading Data for 1933 Boiler Plant and 1945 Extensions*

	Installation 1933		Extensions 1945
	Boilers	Combined reheater units	Combined reheater units
Number of units per 50MW set	2	2	1
Maximum continuous output (each), lb per hour	156,000	125,000	410,000
Steam temperature at superheater outlet, deg. Fah.	825	825	865
Pressure at superheater outlet, lb per square inch	625	625	625
Feed temperature at economiser inlet, (approx.) deg. Fah.	340	340	355
Reheated steam quantity at M.C.R., (each), lb per hour	—	180,000	365,000
Steam temperature at reheater inlet M.C.R., deg. Fah.	—	520	563
Steam temperature at reheater outlet, deg. Fah.	—	825	865
Furnace construction	Bailey	Bailey	Sides : tangent tubes Front & rear : Bailey
Height of drum c.l. above basement	57ft 10in	56ft 9in	95ft
Combustion chamber volume (including furnace hopper), cubic ft	7,650	7,200	30,000
Furnace (cooling) surface, square feet	1,920	1,900	Bailey : 3,510 Tubes : 1,700
Boiler surface, square feet	5,528	4,417	5,250
Superheater surface, square feet	6,800	4,000	10,700
Reheater surface, square feet	—	11,980	45,000
Economiser surface, square feet	8,200	6,770	High temperature : 5,850 Low temperature : 20,600
Air heater surface, square feet	39,600	45,400	93,400

* Abstract of a paper read at a joint meeting of the Institution of Mechanical Engineers and the Institution of Electrical Engineers London, October 24, 1952.

† Partner, Messrs. Merz and McLellan.

‡ Chief generation engineer (operation), North Eastern Division of the British Electricity Authority.

the high-pressure end, one is set at 111 per cent and trips all emergency and governor valves; the other is set at 114 per cent and trips the same valves and also the vacuum-breaking valve, to prevent stored reheater steam from overspeeding the machine as a result of an improperly closed intermediate-pressure valve. The vacuum breaker can be rendered inoperative by a foot pedal when the second trip is being tested. The machine may also be tripped by hand at the steam end or at the field control pedestal.

A vacuum-operated device reduces load if the vacuum falls below 22in of mercury, and trips the machine at the steam and electrical ends on a further fall to 15in. Should this fail, a second device, set at 2 lb per square inch gauge, trips the machine at the same points. These devices ensure that the only likely cause of excessive condenser pressure would be leakage past the high-pressure emergency valve, and this can be dealt with by an atmospheric valve only 12in in diameter instead of the larger valves required on machines not otherwise protected.

The condensers have cupro-nickel tubes ferruled at both ends; half of these can be cleaned at reduced load. Double rows of iron bars protect the top rows of tubes from the impact of moisture or mechanical fragments from the low-pressure spindle. Duplicate steam ejectors have been provided, together with a quick start ejector.

Feed System

Two extraction pumps, each of 100 per cent capacity, are provided for each turbo-alternator. The condensate can be extracted for weighing in the original station test tanks, and returned by a test return pump, but in the new machines a portable precision Venturi meter can alternatively be inserted in place of a corresponding length of pipe to facilitate routine tests.

In an attempt to reduce aeration in the elevated hot wells by an alternative method to the overflowing system, they are maintained at 195 deg. Fah. by steam-heating coils supplied with bled steam from the low-pressure abstraction point, the drain returning through an orifice to the low-pressure heater. Electrical "topping" heat is provided for light-load use. The higher temperature of the hot well requires its connection into the system at the low-pressure heater outlet, where the boiler feed-pump suction main is also connected.

Two motor-driven feed-pumps are provided for each boiler, each of sufficient capacity for full load, thus giving 100 per cent standby. All four are connected to a common discharge header with a single steam-driven pump in the centre, so that by the operation of sectioning valves in the suction and delivery headers, the steam-driven pump can be made available to either unit. No interconnection is provided to the existing feed-pumps on the discharge side, as the new boiler design requires a feed pressure 40 lb per square inch higher than in the old section.

To facilitate quick starting of a standing feed-pump a warming connection has been provided, consisting of a small by-pass across the discharge non-return valve of each pump through which, by opening the suction valve and the by-pass across the delivery valve, hot water may flow back through the standing pump from the discharge header.

Alternators and Exciters

The change of generating voltage from 13·5kV to 11kV has no operational significance, but enables machines and transformers of more standard design to be used. Special care has been taken in the design of the rotor to minimise coil distortion and, in particular, thicker copper than is usual has been used for rotor windings; the excitation current is accordingly higher (about 630A at normal load) and, in view of difficulty experienced with direct-coupled high-speed exciters handling even lower currents, it was decided to use a motor-driven exciter at a speed of 1000 r.p.m.

The same motor also drives the single alternator ventilating fan, an arrangement which helps to maintain exciter speed when the voltage is reduced owing to system faults, because the fan contributes more flywheel effect in proportion to its load than the exciter. The ventilating fan precedes the coolers so that the cooled air passes straight to the alternator. The main and pilot exciters are self-ventilated but the common driving motor is cooled from the main circuit, as are the alternator slip-rings; in the latter case, the air is filtered before being returned to the main circuit.

Boilers

The maximum output of each of the new boilers is 410,000 lb of steam per hour at 625 lb per square inch and 865 deg. Fah., reheating 365,000 lb of steam at 147 lb per square inch from about 563 deg. to 865 deg. Fah. The equivalent evaporation rate on a heat output basis is 460,000lb of steam per hour. This represents a margin, for adverse running conditions, equivalent to 8 per cent of the main steam quantity.

The employment of boilers of large capacity required a careful study of the expected availability of this kind of plant. Considerable guidance was available from experience which had been accumulated with the plant originally installed at this station, covering not only the combustion of a wide variety of fuels typical of those expected for the new plant, but also the installation of a further four pulverised fuel-fired units at various intervals after the initial plant was commissioned in 1933. This enabled developments in design and manufacturing technique, made from time to time, to be tried out in service.

Tests had also been carried out with the earlier plant to ensure that no difficulties would be experienced in running-up the turbo-alternator as a unit with its associated reheater boiler.

The new boilers are of the high-head type and are supported independently of the steelwork of the building. The front and rear walls are of the standard Bailey type with cast iron blocks, while the side walls are formed of bare tangent tubes; this is one of the first applications of this design in Britain. Further particulars of the boiler are given in Table II.

The sixteen double-ported Calumet burners fire horizontally through the front furnace wall in two rows. The average height of the furnace above the burners is 30ft to the screen tubes at the furnace outlet. Secondary air is admitted around the burners, while additional secondary air, supplied through two rows of ports in the rear of the furnace, creates additional turbulence and also gives some measure of control over the length of the flame. Eight retractable oil-burners, for lighting up, disposed in the front-furnace wall, use pressure atomisation and are automatically spark-ignited on reaching their working position.

The single steam-and-water drum is solid-forged with an internal diameter of 4ft 11in and a parallel length of 41ft 3in; it is 3¼in thick and weighs 53 tons. Steam scrubbers and cyclones are installed in the drums to ensure the high degree of purity specified for saturated steam, namely, a maximum of one part per million of solids with a boiler water concentration not exceeding 1000 parts per million, corresponding to a maximum wetness of 0·1 per cent.

Provision was made, in the form of blind nipples in the appropriate headers, for the addition of more convection evaporating surface, should this be found desirable for better adjustment of the superheat temperature. The use of this facility is referred to later.

The superheater is of the self-draining multi-loop type; the primary section is of mild steel and the secondary section of ½ per cent molybdenum steel. Steam temperature is controlled, between 80 and 100 per cent output, by hydraulically-actuated gas by-pass dampers, controlled manually from the boiler control panel. By-pass control was adopted, as being sufficiently rapid in response for use at this temperature and on the grounds of its simplicity and relative immunity from mechanical failures likely to cause boiler outage. Surface desuperheater control, although more sensitive, was considered less reliable; indeed, at the time the plant was designed, surface desuperheaters had, in several installations, been responsible for forced shut-down of boiler plant.

The convection reheater is in two consecutive gas passes, with a division wall of refractory material 34ft high and 34ft wide, the design of which had to allow for the temperature and pressure differences between one side and the other; steam cooling was considered with elements shunted across the reheater but, in view of the difficulty of providing sufficiently rigid elements and of the possible attemperating effect of short circuiting relatively cooled steam to the reheater outlet header (since little heat absorption would take place), it was ultimately decided to retain natural air ventilation by means of a hollow construction, the cooling air entering at the bottom of the wall and emerging under two canopies at the top of the reheater portion of the unit. In view of the method used for supporting the walls, special bricks of light-weight refractory material were used; the total weight of the wall is about 24 tons. The temperature at the reheater outlet is controlled between 80 and 100 per cent of the continuous maximum output by gas by-pass dampers, whose control is identical with that of the superheater by-pass dampers.

The economiser consists of three sections which are in series on the water side, the feed-water entering the lower bank of the main economiser and passing to the upper bank and thence through a "topping" economiser to the boiler drum. On the gas side, the gas passing through the reheater flows through the two banks of the main economiser and then to the air heater, whereas the gas by-passing the reheater flows through the "topping" economiser and the lower bank only of the main economiser, an arrangement which minimises the gas-leaving loss when the reheater is being by-passed on the gas side.

The two vertical-shaft regenerative air pre-heaters have small internal air by-passes and, under banked conditions, dampers and cross-connecting ducts between the main gas and air ducts ensure a cooling circulation of air through both the gas- and air-side elements, to avoid distortion due to unequal expansion, and jamming when starting.

The two forced-draught and two induced-draught fans have inlet vane control, regulated in the former case by manual control from the instrument panel, and in the latter, by the automatic furnace-pressure control. The forced-draught fans are situated on the annexe roof but draw air from above the reheater portion of the boiler, to ensure maximum recovery of heat from the boiler-house generally and from the cooling air issuing from the reheater division wall. The induced-draught fans are at ground level outside the annexe.

Each boiler has four constant-speed ball-and-ring pulverisers, each with its associated primary-air fan, coal feeder, classifier and seal-air fan, and each receives coal from the overhead bunker through a separate automatic coal weigher. The coal-feeder motor is automatically controlled by the primary-air quantity and the amount of coal in the mill; the control is discontinuous, so that the motor runs at one of two speeds or remains stationary.

Each mill is under pressure from a constant-speed primary-air fan, the output of which, and hence the output of the mill, is damper-controlled from the instrument panel. The classifier motor has eight speeds, to facilitate control of the fineness of the mill product. The specified hourly capacity of each mill group is 9 tons of coal, having a moisture content of 8 per cent and a Hardgrove grindability index of 50 per cent; the required fineness of the product is 70 per cent through a 200 B.S. mesh sieve. The capacity was so selected that—except when using very poor coal—three milling groups would suffice for full boiler output, thus leaving one in reserve to permit maintenance without reducing the unit load.

Each boiler has two electrostatic precipitators arranged between the air heater outlets and the induced-draught fans, the gas flowing horizontally through two successive banks of electrodes.

Ash Handling Plant

In the existing stoker-fired boiler-house the clinker ash is conveyed by scraper conveyors into storage bunkers, from which it can be fed direct into rail or road vehicles for disposal, there being a ready market for the clinker ash. In the existing pulverised-fuel boiler-house the ash and dust are both sluiced out and the mixture is pumped to adjacent ground-level storage areas covering, so far 51½ acres, at a depth of 15ft.

Owing to the limited adjacent areas it was decided that the ash and dust for the latest exten-

sions would be dumped at sea. The ash is removed from the furnace hoppers by oscillating high-pressure water jets and is sluiced to a point outside the boiler-house, where it falls, through a rotary crusher if desired, into the ash sump. The ash and water mixture is pumped to a reinforced concrete overhead ash bunker, the surplus water being drained off and returned to the reservoir from which the supply to the high-pressure nozzles is taken. Dust in the economiser and precipitator hoppers is removed by a water-operated vacuum system and passes dry to cyclone separators which deposit it in overhead storage bunkers outside the boiler-house, leaving comparatively dust-free air to pass to the water ejectors. A vacuum-sealed discharge device enables the dust pipe-work and dust separators to be maintained under vacuum while discharging the dust into the reinforced concrete storage bunkers at atmospheric pressure. The high-pressure water required for the ejectors comes from the pumps supplying the ash-sluicing nozzles and returns to the system after passing through the ejectors, forming a closed water circuit as in the case of the ash-sluicing water.

Drained ash discharged from the ash bunker, and the dust discharged from the dust bunkers by the two mixer conveyors with water sprays, pass along a conveyor belt which terminates at the ash wharf in a travelling barge loader. This consists essentially of a tripper with wing conveyors, one of which, fitted with luffing gear, discharges into ash barges in the tidal river, the other discharging over the landward side of the wharf to an underground storage bunker when barge movement is prevented by bad weather. In the latter case, when barge traffic is resumed the underground bunker is emptied into barges by a grabbing crane.

Work on the new extensions commenced on site on January 27, 1947, when the first pile was driven, and the first set (the fifth in the station) was put into service in October, 1949. This was nineteen months after the sixty years' old company had ceased to exist and the ownership of the station had become vested in the British Electricity Authority. The operating results which have so far been obtained from the fifth and sixth machines are described in the second part of this paper.

(To be continued)

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

REELS FOR WIRE

Reels for Covered, Solid, Round Winding Wire for Electrical Purposes, No. 1489 : 1952 ; Reels and Wooden Drums for Bare Wire, Stranded Conductors and Trolley Wire for Use in the United Kingdom, Ref. PD. 1472, Amendment No. 1, to No. 1559 ; and Precision Reels for Bare and Oxidised Resistance Wires (0·0005in—0·0048in diameter, inclusive), No. 1888 : 1952.—Four years ago, when the British Standard for reels for covered winding wires was published, it was thought that it would be a long time before it could be fully adopted in view of the alterations in machinery, &c., that would be required. In practice, however, the standard has proved so successful that it is now possible still further to reduce the range of sizes of reels and this revision of No. 1489, "Reels for Covered, Solid, Round Winding Wires for Electrical Purposes," has now been issued. In the new standard the recommended reels for different gauges of wire have been adjusted in the light of experience, a system of reference numbers has been introduced, marking requirements have been added and other modifications made.

These modifications to No. 1489 have made it necessary to make some adjustment to No. 1559, "Reels and Wooden Drums for Bare Wire, Stranded Conductors and Trolley Wire for use in the United Kingdom," and an amendment slip has been issued.

Manufacturers of certain radio and electronic components have found difficulty in de-reeling very fine resistance wires and it has been shown that unless reels for these wires are made to precision limits, the wire stretches, giving rise to inaccuracies in the manufactured component. Moreover, accurate dimensional standardisation of these reels is an important factor in obtaining efficient service from automatic winding machines. To meet this need, the British Standards Institution has also published No. 1888, "Precision Reels for Bare and Oxidised Resistance Wires (0·0005–0·0048in diameter, inclusive)." Price 2s. 6d. each. The amendment slip is gratis.

American Engineering News

(By our American Correspondent)

Dedication of Hungry Horse Dam

The dedication took place on October 1st of the Hungry Horse dam of the U.S. Bureau of Reclamation in North-Western Montana by President Truman. As part of the ceremony at the dam, President Truman put into operation the first 71·25MW generator of the Hungry Horse power station, thus starting the delivery of the first electric power to become available to the Pacific North-West of the United States from a post-war Federal hydro-electric scheme. The remaining three 71·25MW generators are scheduled to go on the line in December, 1952, August, 1953, and November, 1953, respectively. Almost all of the dam concreting operations, which involved 3,100,000 cubic yards, were completed at the time of the dedication.

The Hungry Horse dam is situated on the south fork of the Flathead River, near the town of Kalispell, Montana. It is one of the major schemes of the U.S. Bureau of Reclamation in the multi-purpose development of the water resources of the Columbia River drainage basin. The dam is a concrete arch gravity structure, 2115ft long at the crest and 564ft high. It has a maximum base width of 330ft and is surmounted by a 30ft wide road. The elevation of the crest of the dam is 3565ft above sea level. The structure is the fourth largest and the third highest concrete dam in the world, being exceeded in height by the 726ft high Hoover dam and the 602ft high Shasta dam. The spillway consists of a reinforced concrete-lined tunnel, having a maximum diameter of 35ft, which taps the reservoir 118ft upstream from the dam and carries the water through bedrock under the right abutment of the dam, returning it to the river 550ft downstream from the dam. The maximum discharge capacity of the spillway is 45,000 cubic feet per second. A ring gate, with a diameter of 64ft and capable of moving 12ft up and down, has been installed in the spillway crest to control the water level. The reservoir will eventually be approximately 34 miles long and 3½ miles wide at the widest point. It will have a total capacity of 3,500,000 acre-feet and a usable storage capacity of 2,980,000 acre-feet. Before water storage could begin, trees and underbrush had to be removed from approximately 27,000 acres of land in the reservoir area, and clearing operations yielded approximately 90,000,000 board-feet of timber.

Massive limestone beds, several thousand feet thick, form the bedrock foundation for the dam. The limestone at the site is exceptionally hard and insoluble, providing canyon walls and a foundation which proved sufficiently strong to permit the construction of an arch gravity design, thus making possible a large saving in materials and cost. Before concrete placement could begin approximately 15ft to 45ft of surface rock was removed from the base and abutments for the dam. Over a million cubic yards of rock, including that removed in tunnels, have been excavated. The 3,100,000 cubic yards of concrete which were required to complete the dam and the power station were produced in a 139ft high concrete mixing plant, erected on the canyon wall 300ft above the river and a short distance downstream from the dam. Concrete pouring began in September, 1949, at a maximum production capacity of 400 cubic yards per hour. Concrete was transported from the mixing plant to the dam in 8 cubic yard, bottom-dump buckets, lowered by four steel cableways spanning the river canyon. Concrete was placed in moulds, 5ft high and varying in area from 2400 to 12,800 square feet.

The power generating facilities are situated in a reinforced concrete building, 394ft long and 76ft wide, which has been built across the river channel at the downstream toe of the dam. Ultimately there will be four 105,000 h.p. turbines, having a total generating capacity of 285MW. The four penstocks are 13ft 6in in diameter and 426ft long, with a maximum operating head of 484ft, the entrances being in the upstream face of the dam, 246ft below the crest. For long-distance transmission the power generated at 13·8kV is stepped up to 115kV and 230kV by eight transformers on the downstream face of the power station. Overhead lines carry the power from the transformers to a switch yard being constructed in the canyon, 1200ft downstream from the dam. Construction of the dam began in 1948 and is expected to involve a total cost of 103,000,000 dollars.

The New Jersey Turnpike

The New Jersey Turnpike Authority has announced the issue of a new revenue bond issue amounting to 28,000,000 dollars, of which some 20,000,000 dollars will be employed to finance improvements of and additional facilities for the toll highway which have become necessary already because of a traffic density far beyond that expected originally. The money is required to build two additional traffic lanes between Camden and Woodbridge, New Jersey, and between the Lincoln tunnel and the George Washington bridge. Furthermore, the funds will be used to add new toll booths and additional access lanes at interchanges ; to provide more service areas and enlarge existing ones ; to put in more work on the shoulders of the road ; to add lights and other safety devices ; to increase toll collection and maintenance staffs ; to revise certain designs and building specifications ; and to settle construction contracts and amounts to be paid for rights of way that could not have been estimated accurately in advance. Plans are now being made for the construction of three extensions to the turnpike : a Jersey City expressway as a link to the Holland tunnel connecting with New York City ; an expressway crossing Newark Bay ; and a connection to the Pennsylvania Turnpike near Florence, New Jersey, across the Delaware River.

The American Bureau of Shipping

Interesting details concerning the technical activities of the American Bureau of Shipping were presented in a recent report by Mr. Walter L. Green, the chairman of the board and president of the Bureau. Immediately following the breaking in two of two "T-2" class welded tankers in January of this year, an exhaustive review was made by the Bureau of all of the information which had been accumulated relating to the design, construction and records of experience in service of the large numbers of this class of vessel registered by the Bureau. This information was presented for discussion, first to the Bureau's committee on naval architecture, and then to the technical committee. Before the meeting of the latter an open discussion was held to which representatives of many of the owners and operators of this class of vessel, not already represented on the committee, were invited to contribute their views. It was finally agreed by the technical committee that the conditions were sufficiently serious to warrant action and made applicable to all the vessels of this kind holding unrestricted classification of the Bureau, and that there were some practicable alterations which could be made to provide additional safeguards against a repetition of such failures as have resulted in the complete severance of the hulls. Accordingly, a directive was issued to all owners of "T-2" tankers classified with the Bureau which called for riveting the bilge keels to the shell and the provision of additional crack-arresting measures in association with additional effective material to increase the overall longitudinal strength. The alterations have been proceeding as rapidly as possible. Unfortunately, curtailment of the supply of steel resulting from the prolonged strike in the steel industry is slowing down the work, so that the programme may take longer than was first anticipated. The committees of the Bureau also agreed that, in conjunction with the United States Coast Guard, a manual should be prepared on the loading of "T-2" tankers for the use of operating personnel. It will provide data to guide them in avoiding conditions of loading or ballasting which might result in unusually severe longitudinal stresses. It is expected that the manual will be available within the next few months.

The recent trend towards the planning of larger ships, particularly tankers and ore carriers, has been continuing. General designs have been submitted to and reviewed by the Bureau for tankers of up to nearly 60,000 deadweight tons.

There are actually under contract to be built to Bureau classification in the United States, the United Kingdom, Germany and Japan a number of tankers of over 38,000 deadweight tons, including some slightly over 45,000 tons. Some of these ships are more than 700ft in length between perpendiculars and have beams ranging from 95ft to over 100ft. These figures are of particular interest when compared with the 662ft 7in length and 93ft 3in beam of the S.S. "America," which, prior to the completion of the S.S. "United States," was the largest merchant vessel ever built in United States shipyards. In the development of the designs for these large ships it is being found that limitations on draught imposed at ports, or by intermediate channels or canals, are becoming a dominating factor in influencing the general dimensions. To obtain the large weight-carrying capacity it is necessary to develop designs having an unusually large ratio of the length and beam to the draught, and since additional cubic capacity such as would be acquired by increasing the depth of the ship is not necessary, naval architects have been forced to develop designs having the least depth which will provide the necessary strength and stiffness in the structure. This crowding of the depth to a minimum has resulted in the necessity of using plates for the shell and decks of thicknesses never before contemplated for shipbuilding purposes in order to obtain the necessary strength of the hull girder. This, in turn, places further emphasis on the importance of adequate specifications to ensure a proper quality of material.

At the annual meeting of the Bureau in January it was reported that three of the major American repair yards, all on the East Coast, had received Bureau approval to carry out repairs to shafting by welding, and it is expected that these qualifications will be acquired by yards on both coasts and the Gulf.

Crossing the Hudson

To relieve "the intolerable street traffic congestion in midtown Manhattan" the commissioners of the Port of New York Authority have at last authorised the construction of a third tube for the Lincoln tunnel which crosses the Hudson River, connecting the west side of Manhattan with Weehawken, New Jersey. After a ground-breaking ceremony on September 25th work began on the first shaft to be sunk for the new tube. The tube will have a portal-to-portal length of 7944ft, an external diameter of 31ft and a 21ft 6in wide roadway, and is expected to cost 90,000,000 dollars. It will be parallel to and south of the existing tubes between West Thirty-eighth Street in Manhattan and Weehawken. In Manhattan the third tube will extend to a new portal at the north-east corner of Thirty-eighth Street and Tenth Avenue, adjacent to and south of the exit portal of the present south tube now used solely for eastbound traffic. The north tube will continue to serve westbound traffic, but when the third tube is completed the existing south tube will be a reversible artery, handling Manhattan-bound traffic in the mornings and at the end of holiday periods, and carrying traffic to New Jersey at nightfall and at the start of holidays. The third tube will replace the present south tube as the eastbound carrier. In most respects the third tube will be similar in design to the existing north and south tubes of the Lincoln tunnel, but will be lighted by continuous fluorescent tubing, about the only change in tunnel design since the Port Authority completed the construction twenty-five years ago of the Holland tunnel, which was the first tube for motor vehicles to be built under the Hudson River. Although the third tube being added to the Lincoln tunnel is a major step towards catching up with the steadily increasing motor traffic across the Hudson, the Authority has reason to believe that it will be crowded soon after it is completed in 1957. Meanwhile the streets of New York City are groaning under the existing load, with traffic backing up on West Side streets to such an extent that on three recent Friday evenings it was necessary to shut off the flow through the existing twin tubes of the Lincoln tunnel and re-route vehicles bound for New Jersey to the George Washington bridge, seven miles north of the midtown Hudson tunnel.

Work on the third tube was delayed for fifteen months by the insistence of Mayor Impellitteri and Robert Moses, the construction co-ordinator of New York City, that the Port Authority should provide adequate street connections on the busy Manhattan West Side. A compromise was finally worked out by which, in addition to providing street links at a cost of 23,500,000 dollars when the additional two-lane tube is opened, the Authority is committed to spend another 5,000,000 dollars, if the city so requests, to speed the movement of its tunnel-generated traffic by constructing an interchange system connection to the West Side Highway of Manhattan. This agreement is contingent on Lincoln tunnel traffic reaching 30,000,000 vehicles a year, a figure that appeared fantastic a few years ago, but is very realistic now. The present four-lane tunnel will carry nearly 20,000,000 vehicles this year; the additional tube will increase the tunnel capacity by 50 per cent and double the peak-hour capacity. Fully aware that by the time the third tube is in operation, new facilities will be needed to keep pace with the surging traffic, the Port Authority has now recommended that a new tunnel crossing should link the congested market area of West Fourteenth Street in Manhattan and Hoboken, New Jersey, where the Authority is re-habilitating the waterfront. It is considered likely that the two programmes will be integrated, but details have not as yet been perfected.

While the new Lincoln tunnel tube will help to speed travel between the port district and northern New Jersey and New York, it will add to the traffic woes in New York City, just as the recently completed New Jersey Turnpike generated additional traffic for both the Lincoln tunnel and the George Washington bridge. How New York City and the municipalities in New Jersey will tackle the problem of handling the vehicles that will use the new facility must still be worked out, and the issue of adequate street connections must be threshed out well in advance of the start of construction.

An Electrical Conductor Aluminium Alloy

The General Electric Company, of Schenectady, New York, has announced the development of an aluminium alloy called "Cond-Al," particularly for winding high-speed large-diameter generator rotors, which has enabled the company to undertake the production of four 216MVA, 3600 r.p.m. steam turbo-generators; they will be larger than any previously manufactured by the company. The use of the alloy removes certain previous limitations imposed by conventional winding materials upon the size of 3600 r.p.m. generator fields. "Cond-Al" (a contraction of "conductivity aluminium") is composed of 99·15 per cent aluminium, 0·45 per cent iron, 0·3 per cent magnesium, and 0·1 per cent silicon, and its suitability for the present application depends on its light weight, high conductivity, creep strength, and thermal stability. The alloy has an electrical conductivity of 59 per cent of standard copper, compared with a conductivity of 61 per cent possessed by the standard American "EC" grade of aluminium used for electrical conductors. At 25 deg. Cent. it has more than four times the compressive yield strength of the "EC" grade of aluminium. At a temperature of 140 deg. Cent. its compression creep is less than one-fiftieth of that of the "EC" grade of aluminium at moderate stress and still less, relatively, at higher stresses. The fatigue strength of the alloy is about the same as that of cold-worked, silver-bearing copper. "Cond-Al" is being made for the company by the Aluminium Company of America.

The construction of the first four turbo-generators using the new alloy is proceeding at the turbine shop at Schenectady. When assembled, the 216MVA units will each weigh more than 600 tons and will be 82ft long, 17ft wide, and more than 10ft high above floor level. Because of railway clearance and weight limitations the generator stator of each of the units will be too large for shipment intact. A method of double-frame construction has therefore been adopted, the outer frame being split for transport in three sections.

French Engineering News

(By our French Correspondent)

Some rich coal seams have been found in the Jura. According to a recent report these seams, which are situated near Lonsle-Saulnier, comprise several hundred million tons of coal. A scheme is now being prepared to work the seams, but it is estimated that long and difficult preparations will preclude any substantial output of coal before 1960.

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Panhard is now manufacturing armoured vehicles equipped with twelve-cylinder, air-cooled 200 h.p. engines, which are stated to give a cruising speed of well over 100km per hour. The use of an air-cooled engine is said to be of some importance, since it means that the cooling water problem is cut out. This vehicle is expected to go into large scale production. The well-known Panhard AMD 178 vehicle is still being used by the French Army, but the new vehicle is claimed to be superior in every way.

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The first of four large suction pumps for grain has been installed in the Sud d'Arene silos at Marseille. A "Goliath" travelling crane was used to carry out the installation. The pump weighs about 120 tons and comprises several turbo-blowers each equipped with four pipes; dusting and cleansing apparatus is also included. These pumps have been built by the Italian firm of Regaine, whose tender was accepted after the examination of estimates from several countries. The steel frame upon which the pumps are built was constructed by the Forges d'Ales from Italian specifications. The electrical equipment is all French. The pump has a capacity of about 1000 tons of grain per hour, that is 250 tons per pipe, and the grain is delivered on to four endless belt conveyors leading to the silo 575 yards away. A tower for handling and measuring the grain has been constructed at the north of the silo. It contains grain elevators, tip scales and special distributors, all of which are automatic, serving the different cells of the silo.

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The Anglo-Iranian Oil Company's new £17,000,000 refinery at Dunkirk, which has now been opened, has a production capacity of 2,000,000 tons per annum. Dunkirk is now the third largest port in France and some £12,000,000 have been spent on its reconstruction. The jetties of the Societe Generale des Huiles de Petrol B.P., are at the western end of the harbour and behind them is the refinery and its lines of storage tanks. Originally, the refinery was designed to produce 1·3 million tons, but this figure was increased in order to meet France's growing oil consumption. At the same time, the company's refinery at Averan, about 30 miles from Marseilles, is also being developed. Built in 1932, it was designed to produce about 400,000 tons, but since 1945 that figure has now been increased to 2,000,000 tons.

* * *

The French Ministry of Public Works has drawn up a memorandum which is designed to reduce production costs at French shipyards which are losing orders because estimates are far too high.

The memorandum calls for more specialisation, and suggests that yards should concentrate on the construction of individual types of craft. It also asks that all shipyards should adopt scientific organisation and that work should be planned in such a way as to ensure that there is no loss of time. Dealing with the matter of simplification, the Ministry contends that at the moment many shipyards still use old methods or pay too much attention to detail. It appeals to the yards not to concentrate on elaborate detail, as this is often responsible for increased costs.

* * *

The Ste. des Freins et Signaux Westinghouse has announced that it is now making a germanium crystal rectifier in the form of diode and triode prototypes. The French Ministry of Posts and Telegraphs has now taken up the diodes for use in telecommunications. The plant at Freinville is turning out about 10,000 every month and by 1953 it is hoped that production will reach about 12,000. Triodes are being produced on a more or less limited scale.

Industrial and Labour Notes

Engineering and Shipbuilding Wages

On Wednesday of last week, there was a meeting between representatives of the Shipbuilding Employers' Federation and the Confederation of Shipbuilding and Engineering Unions to discuss wages in the shipbuilding and ship-repairing industries. A claim for a "substantial increase" in wages was rejected by the Employers' Federation some weeks ago. During these latest talks, the employers' representatives made an offer of a general wage increase of 7s. 6d. a week. The union representatives stated that they themselves could not accept the offer, but would put it, without recommendation, to a delegate conference of the thirty-eight unions affiliated to the Confederation of Shipbuilding and Engineering Unions.

The delegate conference was being arranged to take place on Wednesday of this week, and at the time of going to press there is no news of its deliberations available. As well as the offer made by the shipbuilding employers, the conference was required to consider the offer—recorded in our last issue—of a wage increase of 2d. an hour, which has been made by the Engineering and Allied Employers' National Federation. The attitude adopted by the union representatives in respect of that offer was that it was unacceptable, but that they would put it before the delegate conference.

The Iron and Steel Industry

On Thursday of last week, the Government's proposals for the future of the iron and steel industry were debated in the House of Commons. A Government motion approving the proposals set out in the recent White Paper was carried by a majority of thirty-four.

Opening the debate, the Minister of Supply, Mr. Duncan Sandys, said that the Government's proposals had two main objectives. The first was to restore conditions of independence, initiative and enterprise in the iron and steel industry, and the other was to provide effective means for the supervision of the whole of the industry, and thus bring to an end the arbitrary division created by the Iron and Steel Act, 1949. The present organisation set up by that Act, the Minister said, possessed all the usual and fundamental weaknesses of any system of nationalisation. The fact that the steel companies were accountable to the State Corporation, which, unlike an ordinary body of shareholders, was in continuous session and had its own staff of experts, must inevitably sap the individual initiative of the companies and create among them an over-cautious and bureaucratic outlook. Another result of nationalisation had been to create a vast state monopoly, a monopoly outside the purview of the Monopolies Commission and one which provided no adequate protection for the consumer. It was true that there was a consumers' council, but the Minister suggested that that form of indirect consultation was no substitute for the direct participation of the consumers on the supervisory board which the Government now proposed. In addition, Mr. Sandys pointed out, in the process of nationalisation, the state was inevitably obliged to take over extensive engineering and other extraneous activities outside the steel industry because they happened to form part of the undertakings which were nationalised. It was altogether inappropriate that a national steel corporation should control and finance large businesses in other industries which were not nationalised.

Mr. Sandys went on to say that, to carry out its two objectives, the Government proposed to set up two distinct bodies, a board to supervise the industry and an agency to take over and dispose of the assets now owned by the State. The agency would act on behalf of the Treasury in a dual capacity, as a holding company and as a disposals organisation. It would be financed by the Treasury and any money it received over and above its current needs would be paid into the Exchequer. It was proposed to give to the agency very wide discretion in the planning and timing of its selling operations, and it was also proposed to give it power to effect amalgamations and modifications of capital structure in the companies before offering them for sale.

Iron and Steel Allocations

The Ministry of Supply has announced that as from January 1st next, no distinction will be made in allocation between alloy iron and steel and non-alloy steel. Consumers will then be free to choose how much of either material—within their total authorised tonnages—they wish to acquire, instead of having amounts specified for each. There will be an exception—tinplate, terneplate and blackplate—which will remain separately allocated as at present. Those who already hold authorisations for periods in 1953 for alloy and non-alloy materials separately will shortly receive authority to treat them as applicable to either kind of material.

Free Trading in Zinc

In the House of Lords, on Thursday of last week, Lord Swinton announced that it was hoped that free trading in zinc could be resumed on the London Metal Exchange on January 1st next. Discussions to that end, Lord Swinton said, were to take place at once between the Ministry of Materials and the trade and other interests concerned. From the date of reversion, the private import and sale of virgin zinc would be permitted, and the London Metal Exchange would re-open for transactions in zinc. The Ministry of Materials, Lord Swinton stated, would cease to trade in zinc except to the extent necessary to wind up its trading operations.

Paying tribute to the help afforded by suppliers at home, in the Commonwealth and other overseas countries in meeting supply difficulties, Lord Swinton said that present and prospective supplies of zinc were ample. It was, therefore, in the interests of all concerned to free the market and support free dealing. When the market resumed, stocks held by the Government would be large.

On Wednesday, the Ministry of Materials announced a reduction in the price of good ordinary brand zinc from £118 to £110 a ton.

World Industrial Production

The statistical office of the United Nations has calculated that the volume of world mining and manufacturing production in the second quarter of this year was 2 per cent lower than in the first quarter. A report on the subject, which has just been issued by the economic section of United Nations, says that the overall decline during the second quarter was contrary to the seasonal pattern of world production, which normally expands during that period. Moreover, it was the first time in the post-war years that total output failed to exceed the level of the corresponding quarter of the preceding year.

The report goes on to suggest that the steel strike in the U.S.A. was undoubtedly a major factor in the decline in world industrial output during the second quarter. Steel output in the U.S.A. in the second quarter of this year was approximately one-third lower than in the first quarter. Another contributory factor to the decline in world industrial output has been that the upward trend of European production was not maintained during the second quarter of this year. During that period, the report says, the level of mining and manufacturing production in Europe as a whole was 1 per cent below that of the corresponding quarter of 1951. The fall in the European index in the second quarter, it is asserted, resulted in a large measure from the sharp drop in the industrial production of the United Kingdom, where output was approximately 7 per cent below the level of the first quarter and 8 per cent below that of the corresponding quarter of last year.

In other industrial countries for which data relative to the second quarter of this year have been made available, there were decreases in output of 1 per cent to 7 per cent, when compared with the corresponding quarter of 1951, reported by Belgium, Canada, Denmark, The Netherlands and Sweden. On the other hand, the report states, increases of 3 per cent to 4 per cent, compared with the second quarter of 1951, occurred in France, Western Germany and Japan. In India and the U.S.S.R. output in the second quarter of this year was reckoned as being 7 per cent and 11 per cent, respectively, above the corresponding quarter of last year.

Road Haulage Charges

The Association of British Chambers of Commerce has reaffirmed "its complete opposition to the principle of a levy to be imposed on road haulage vehicles for the purposes described in the Transport Bill." The Association considers that the worst feature of the levy is the intention that some part of its proceeds would be used to subsidise the railways. At the same time, the Association urges that the principle of an impost upon the users of road transport in order to rectify the political miscalculations made through the nationalisation of road transport, cannot be considered equitable. Any levy imposed upon road hauliers, the Association claims, would inevitably be reflected in the charges made for road services.

Employment in Northern Ireland

Speaking, last week, in the Northern Ireland House of Commons, the Minister of Commerce said that employment in the industries of Northern Ireland rose from 154,000 in 1935 to 226,000 in 1950. As far as could be seen, the census for 1951 would show a further rise of 5000 over 1950. Between 1935 and 1951, therefore, there had been an increase of about 50 per cent in industrial employment.

The Minister went on to say that, during the twelve months ended September 30th last, fourteen firms agreed to establish or expand production in Northern Ireland with assistance from the Government. Four of them were already in production, and there was every reason to hope that, in the case of the other ten, production would soon begin. The total anticipated employment in those undertakings was over 3400.

Furthermore, the Minister stated, there were ten factories, with a total area of over 300,000 square feet which the Government has decided to build, but on which construction had not yet started. One of the factories had already been allocated to a firm; the remaining nine having been planned for sites throughout Northern Ireland in the hope of attracting firms to those areas.

The Census of Production

An Order has been made by the Board of Trade indicating the scope of the Census of Production which is to be taken in 1953 and will cover the present year. Undertakings producing coal, gas, electricity, oil shale, crude or refined petroleum or shale oil products are exempted from making census returns to the extent to which they already supply the necessary information to the Minister of Fuel. As already announced, "sampling" will be used for the first time in the next census, in view of the fact that details of output and the usage of certain materials were obtained in the census for 1951. The adoption of sampling methods will relieve a large proportion of the smaller and medium-sized establishments of the need to make a return.

The Census of Production to be taken in 1954 will relate to the year 1953 and will be on the same simplified basis as that to be taken next year. Both censuses will cover all producing industries and returns will be required from all firms over a certain size in each trade. The statutory form of return for both years will include questions on working proprietors; average employment during the year; wages and salaries; plant, machinery and vehicles; new building work; total materials purchased; work given out; stocks at the beginning and end of the year; total output and transport payments.

Notes and Memoranda

Rail and Road

CONCRETE ROADS.—A recent publication of the Cement and Concrete Association, 52, Grosvenor Gardens, London, S.W.1, is entitled *Construction of Concrete Roads*, by W. P. Andrews. It briefly summarises current methods of design and construction, with notes on materials and plant, "in a form that will be most convenient for use by the busy practising engineer." The Association has also published recently brochures entitled *Spa Green Estate* and *Factory at Brynmawr*; copies of all these publications may be obtained from the Association at the above address.

ROAD STATISTICS.—The British Road Federation has just issued its annual publication "British Road Statistics, Great Britain, 1951." This collection of facts and figures on the roads of this country provides a useful source of condensed tabular information concerning the numbers and types of road vehicles, taxation, roads finance, &c., accidents, traffic density, fuel consumption, the transport industry, &c. The figures for 1951 show that the number of vehicles on the roads continued to increase and totalled over 4,620,900; vehicle density at 18·1 per mile of roads was greater than in any other country; and of the 1,991 million gallons of motor fuel consumed in 1951, some 85 per cent was by commercial vehicles. The book is published by the Federation at 4A, Bloomsbury Place, London, W.C.1, price 1s. net.

DUMFRIES SIGNALLING SCHEME.—The Scottish Region of British Railways states that work has started at Dumfries, on the Glasgow-Kilmarnock-Carlisle main line, on a major scheme of modernisation of signalling arrangements and improvements to the permanent way layout which is designed to speed up traffic operation. The plans authorised include the provision of colour light signals to replace the existing semaphore ones, and the simplification of the permanent way layout. There are five signal boxes at Dumfries and these are to be abolished and replaced by two modern boxes, one near the present No. 1 box on the Carlisle departure side of the station, and the other sited near the existing No. 4 signal box. The project is to completed in five stages. The No. 3 signal box has been dispensed with already, and the remaining boxes will be removed in the final stage of the scheme. Considerable permanent way alterations have been carried out, particularly in connection with the extension of the carriage sidings on the down side of the line at the north end of Dumfries station.

Air and Water

SHIPBUILDING STEEL ALLOCATION.—The Admiralty has stated that the allocation of steel for shipbuilding for the first quarter of 1953 will be 9 per cent higher than the allocation for the current quarter.

FRENCH LINE MAGAZINE.—We have recently received a copy of the company magazine "France via the French Line," which the Compagnie Generale Transatlantique, has decided to re-introduce; publication was interrupted by the war. The first issue includes a short illustrated history of the company, followed by a photographic supplement of Paris by night, and some notes upon the maiden voyage of the "Flandre." The city of Lyons and the mediæval city of Peronges are briefly described and illustrated, and there is included an impression of Morocco.

"COMETS" FOR AMERICA.—Pan American World Airways, Incorporated, has approved the purchase of three "Comet" series 3 passenger liners for delivery in 1956. This delivery date was made possible because Sir Miles Thomas, chairman of the British Overseas Airways Corporation, had agreed to release early deliveries which had been earmarked for B.O.A.C. The de Havilland "Comet" series 3, capable of carrying a full payload of passengers, mail and cargo for 2700 miles against a 50 m.p.h. headwind with adequate reserves, will be the first jet transport able to operate efficiently over the principal routes of the Pan American system. The contract includes a two-year option for seven additional "Comets" for delivery in 1957.

MARINE GAS TURBINE.—The oil tanker "Auris," which is owned by the Anglo-Saxon Petroleum Company, Ltd., has completed one year's service with one of the four generators supplying propulsive power driven by a gas turbine. The turbine has run continuously during the period, while the ship covered a distance of 52,878 nautical miles, and the consumption of lubricating oil and fuel compares favourably with a steam turbine of equal power. Maintenance at sea has been a minimum and the overhaul has taken three days against the three weeks required for the diesel engines driving the other three generators. The new 18,000-ton deadweight tankers now being designed for the Shell group will be propelled by twin gas turbines developing 8300 b.h.p.

Miscellanea

THE BUSINESS EFFICIENCY EXHIBITION.—The thirty-ninth Business Efficiency Exhibition will be opened at Kelvin Hall, Glasgow, on Tuesday next, November 4th. The products of sixty exhibitors which are to be shown, will represent a wide field of office and administrative equipment.

TIMBER DEVELOPMENT ASSOCIATION.—The Timber Development Association, 21, College Hill, London, E.C.4, has recently published a booklet entitled *The Aims and Activities of the T.D.A.*, to give a general idea of its work. Copies may be obtained on application to the Association at the above address. The latest in the Association's series of design sheets entitled *Timber Ground Floor for Housing*, has also just been issued.

LEAD PRICES AND CONTROLS.—Speaking at the Exide Motor Show luncheon last week, Mr. H. V. Schofield, Sales Director of Chloride Batteries, Ltd., quoted an example of the influence of controls on prices. He said that the abolition of the control of lead (the major raw material used by his company) had been followed by a dramatic reduction in its price. In nine months the price of lead had fallen from £185 per ton to £80—£85 per ton.

COLONEL J. S. A. WALKER.—We have learned with regret of the death of Colonel J. S. A. Walker, M.I.C.E., M.I.Mech.E., which occurred at Ruthin Castle, North Wales, on October 17th. Colonel Walker, who was sixty-five, was vice-chairman of Walker Brothers (Wigan), Ltd., with which firm he had been actively engaged as a full-time director until his retirement in 1947. He was a part-time member of the North Western Electricity Board, and chairman of the governing body of the Wigan and District Mining and Technical College.

UNDER-WATER OIL DRILLING.—The Shell Petroleum Company, Ltd., announces that the first major submarine oil drilling operation in the British Commonwealth will be started shortly off the coast of British Borneo. The plan is to drill wells into the sea bed to find an extension of the Seria Oilfield, which is now producing at 5,000,000 tons per annum. Four wells are to be drilled from a single platform which is capable of supporting 200 tons, measures 110ft by 45ft, and is supported on a jacket consisting of twenty-eight 24in diameter vertical steel guide piles braced together.

TRAINING IN THE STEEL INDUSTRY.—A booklet, entitled *The Recruitment and Training of Senior Staff*, has been published by the United Steel Companies, Ltd., Sheffield. It sets out the company's general policy of recruitment and training of staff for senior technical, scientific and administrative positions, pointing out that the majority of the appointments are made by promotions within the organisation. The methods of selection and training are described and the letterpress of the booklet is interleaved with some excellent illustrations showing different departments of the various companies which form the United Steel Companies, Ltd.

A JOINTING COMPOUND.—A new jointing compound which has been introduced by Richard Klinger, Ltd., Sidcup, Kent, is designed to increase the tightness and life of metal-faced gaskets and to replace gaskets of secondary importance, such as of paper or similar materials. The makers state that the compound withstands pressures up to some 1400 lb per square inch and temperatures up to 572 deg. Fah. It is non-inflammable, resistant to many chemicals and can be easily applied without the use of special tools. Joints made with the compound do not actually stick together and its use does not involve any difficulties when dismantling.

WATER-TIGHT PENDANT SWITCHES.—An all rubber-covered, water-tight pendant push-button switch has been introduced by ASEA Electric, Ltd., London, E.17, for use on hoist blocks, cranes, &c., operating out-of-doors or in wet or corrosive conditions. The main body of this switch is moulded entirely of rubber except for an inset metal ring for fixing to the handle; this carries the buttons in an aluminium frame which is also covered with a thick layer of moulded rubber. The switch mechanism is sealed behind a flexible rubber diaphragm. Single motor or two-motor reversing switches are being made with double-pole contacts able to handle the full current of squirrel cage motors up to 2 h.p. on 400V, three-phase supply or contactor coils of the largest size.

TEMPORARY LOW-POWER TV STATIONS.—The Government has decided to allow temporary transmitters to be installed at Pontop Pike in north-east England and near Belfast, in Northern Ireland, so that viewers in the neighbourhood of these stations may have television in time for the Coronation. It is proposed to use temporary transmitters having a power of 1kW vision and ½kW sound. They will not give the range and quality that will ultimately be obtained from the five (at present deferred by the Government) permanent medium-power stations and there will be a greater risk of breakdown. Pontop Pike is expected to serve about 1,000,000 people within a radius of some 20 miles, which includes Tyneside; the transmitter in Northern Ireland will serve about 500,000 people in and around the city of Belfast. The transmissions from both stations will be horizontally polarised. The frequencies used will be: Pontop Pike, vision 66·75 Mc/s, sound 63·25 Mc/s, shared with Wenvoe; Belfast, vision 45·0 Mc/s, sound 41·5 Mc/s, shared with Alexandra Palace.

A GOLDEN JUBILEE.—We attended last week a reception given by Williams and Womersley, Ltd., in celebration of its golden jubilee. The firm was founded in 1902 by the partnership of two young men, George Williams and Herbert Womersley, who set up in business as engineers and millwrights at Wakefield, Yorkshire. The premises first occupied by the firm were known as Rosa Works, a very modest property which was rented for £15 a year. Here, the firm began its work, specialising in the production of various appliances requisite for the transmission of power, including shafting, pulleys, bearings and gearing. The story of the subsequent development of the business is admirably recorded in an attractive brochure which the company has produced in honour of its jubilee. A limited liability company was formed in 1938, with Mr. Herbert Womersley as governing director. Upon his death in 1941, Mr. A. W. Boulton was appointed chairman, in which office he continues. The firm's headquarters are still at Wakefield, and its main interest is the production of power transmission equipment for all kinds of trades at home and overseas.

ECONOMY MEMORANDA FOR CEMENT AND BRICKS.—In continuance of the campaign for greater economy in the use of building materials, the Ministry of Works has now issued two Economy Memoranda for Cement. One makes recommendations to help those engaged in small-scale building (including housing); the other is concerned with cement in engineering and large-scale projects. Both memoranda stress the advantages and economies accruing from the use of ready-mixed concrete and bulk delivery of cement; and from measures on the site, such as careful quality control, proper mix proportions of mortars and renderings, and selection of aggregate sizes. They may be obtained from H.M. Stationery Office, price 3d. each. An economy memorandum for bricks, entitled *Using Bricks to Best Advantage*, has also been issued by the Ministry, and may be obtained for a price of 2d.

THE B.R.M. RACING CARS.—The assets of B.R.M. Trust, which is to remain in being, have recently been purchased by Rubery, Owen and Co., Ltd. It is stated by Rubery, Owen and Co., Ltd., that it does not intend to enter the field of motor car manufacturers, nor to race motor cars itself, but it may design and develop a new engine to comply with the next Formula I International Grand Prix motor racing. Mr. Raymond Mays and Mr. Peter Berthon, who were directors of B.R.M., Ltd., will be associated with Rubery, Owen and Co., Ltd., in this venture. The company does not intend to announce any new engine or other component which may be developed by Rubery, Owen and Co., Ltd., arising out of the purchase of the assets of B.R.M., Ltd., until any such engine or other component is absolutely ready for racing. Mr. A. G. B. Owen, chairman of Rubery, Owen and Co., Ltd., and formerly chairman of B.R.M., Ltd., states that the Trust did, in fact, carry out the objective set before it. Grand Prix cars to the existing formula were produced and, despite great and sometimes unforeseen difficulties, were proved successful this year in some races—notably at Goodwood in the International Meeting when they finished first, second and third in line ahead. The project came to an untimely end owing to the present formula having, in effect, terminated two years before its term was run. Rubery, Owen and Co., Ltd., has, in its purchase of the assets of B.R.M., Ltd., the prime objective of furthering the prestige of British goods abroad. Rubery, Owen and Co., Ltd., may allow the present B.R.M. cars, which will still continue to be called B.R.M.s, to be raced by some person, or persons, in the few remaining events open to them next year.

Personal and Business

MR. BONNER W. A. DICKSON, formerly a director of Vickers-Armstrong, Ltd., has joined the board of Oliver Pell Control, Ltd.

THE BELMOS COMPANY, Ltd., Columbia House, Aldwych, London, W.C.2, states that its telephone number is now Chancery 5855.

MR. F. R. L. BARNWELL, A.M.I.C.E., has been appointed district engineer at Shrewsbury in the Western Region of British Railways.

MESSRS. J. D. AND D. M. WATSON, 18, Queen Anne's Gate, London, S.W.1, announce that Mr. H. Roy Oakley, M.Sc., A.M.I.C.E., has been taken into partnership.

THE HON. M. F. P. LUBBOCK, a director of Rolls-Royce, Ltd., and Mr. M. D. N. Wyatt, chairman of Airwork, Ltd., have been appointed to the board of Saunders-Roe, Ltd.

THE MINISTRY OF CIVIL AVIATION states that Mr. C. G. Phillips, B.Sc., has been appointed Director of Navigational Services (Telecommunications), in succession to Mr. R. W. J. Sullivan, B.Sc.

SHELL-MEX AND B.P., Ltd., states that its head office marketing departments have been divided into two groups—retail and industrial. Mr. C. K. Stringer is assistant general sales manager, retail, and Mr. H. Cunliffe, assistant general sales manager, industrial.

PATERSON HUGHES ENGINEERING COMPANY, Ltd., has moved its Midlands office to larger premises at 3, Highfield Road, Edgbaston, Birmingham, 15 (telephone, Edgbaston 1639). Mr. J. Ford is the area manager, and Mr. L. R. Kemp is the area sales engineer.

HENRY BERRY AND CO., Ltd., Hunslet, Leeds, 10, states that Major W. Berry is relinquishing his position as managing director, but will continue to serve as chairman of the company. Mr. P. G. Corin, M.I.C.E., and Mr. A. Walker have been appointed joint managing directors.

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, Glasgow, announces that Mr. James Lenaghan, who for a number of years has been a director and general manager of William Gray and Co., Ltd., has been appointed shipbuilding director of the company and will take up his appointment in the new year.

AVELING-BARFORD, Ltd., Grantham, announces the forthcoming retirement of Mr. E. R. Howlett, director and general works manager, and Mr. C. J. Ritchie, director and general sales manager. Mr. Howlett has been connected with the company and its predecessors for forty-six years, and Mr. Ritchie for thirty-three years.

THE NATIONAL ASSOCIATION OF MARINE ENGINE-BUILDERS announces that at the annual general meeting, held in Edinburgh on October 23rd, Mr. W. H. Purdie, a director of W. Doxford and Sons, Ltd., was re-elected chairman for 1952–53, and Mr. E. H. Smith, a director of David Rowan and Co., Ltd., was re-elected vice-chairman.

British Patent Specifications

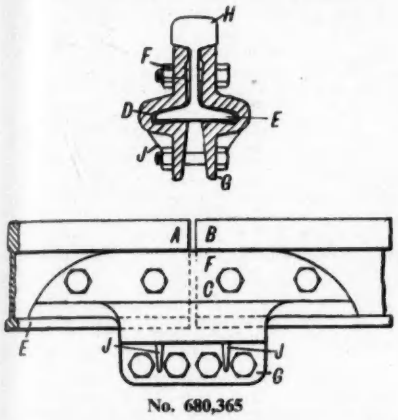
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

RAILWAY ENGINEERING

680,365. February 22, 1950.—RAIL JOINTS AND FISH-PLATES, Frank John Osterman, 18, Terrace Road, Mountain View, Orange Grove, Johannesburg, Transvaal Province, Union of South Africa.

As shown in the drawings, the abutting rail sections *A*, *B* are joined by fish-plates *C*, each of which comprises a U-shaped member *D* embracing the rail flange *E* and having upward and downward extensions forming the plates *F* and *G*. The plate *F* fits between the rail flange and the head and has its inner



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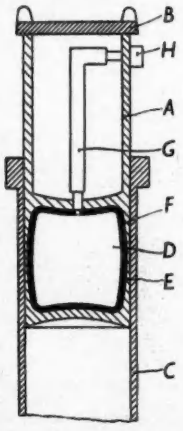
top edge thickened, forming a substantially concave inner face. The lower plate *G* is inclined at a small angle away from the normal to the U-shaped member *D* and is provided with gussets *J*. In use, due to the fact that the rail ends are firmly gripped in close proximity to their abutting ends while the joint as a whole is capable of limited bending movement about the bearing surfaces of the extensions, it has been found that a very appreciable reduction in wear and noise is effected.—*October* 1, 1952.

MINING ENGINEERING

680,310. July 13, 1950.—PIT PROPS, Gutehoffnungshutte Oberhausen Aktiengesellschaft, Oberhausen, Rheinland, Germany.

The drawing illustrates a pneumatic pit prop according to the invention. The inner prop member, consisting of a tube *A* with prop head *B*, slides in the tubular outer member *C*. At the opposite end of the tube to that of the prop head there is a hollow chamber *D* formed between a partition wall, the inner closed end of the tube *A* and the outer wall *E*. This chamber has a cross section and is so dimensioned in the region where it abuts against the outer prop *C* that it can expand to a certain extent without leaving any permanent deformation. Within the hollow space *D* is the inflatable vessel *F* of rubber. This vessel is connected through a pipe *G* with a compressed air valve *H* and is inflated by compressed air. This expands the wall *E* of the hollow space *D* against the inner wall of the outer prop member *C*. The extent of this clamping friction determines the sinking load of the prop, and the air pressure can be released when it is required to remove the prop.—*October* 1, 1952.



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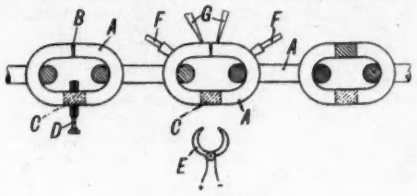
WELDING APPLIANCES

679,595. January 3, 1951.—AUTOMATIC RESISTANCE WELDING OF CHAIN LINKS, Gutehoffnungshutte Oberhausen Aktiengesellschaft, (22a) Oberhausen (Rheinland), Germany.

The manner in which the invention is carried out is shown in the accompanying drawing. The chain links *A*, which are in the first place bent in an automatic bending machine in the cold state to form a continuous chain, have, before being welded together, a wedge-shaped butt joint *B*. In the central region *C* of the closed link limb, lying opposite this butt joint, the links are heated by a device, such as a gas ring burner *D* or an electric coil *E* to a temperature lying, say, between the desired limits for temporarily reducing the yield point of the material at this place. At the same time the limb halves lying opposite the heated zone are engaged from the head ends of the link by pressure-applying members *F*, preferably brought to bear obliquely, and the electrodes *G*



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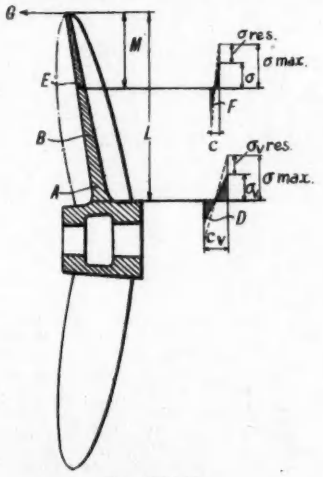
are applied in the vicinity of the butt joint. After the arc has been struck the welded joint is made from within outwards over the entire cross-section of the link, the welded limb being brought by the pressure-applying members into a straightened-out position parallel to the other limb. On completion the pressure members, the electrodes and the heating device are automatically removed from the link. The chain is then moved on in the machine by two links. The welded place and the heated zone opposite cool down substantially uniformly, so that internal stresses which would occur with one-sided shrinkage are avoided. After all the links lying in one plane have been welded the chain is turned through 90 deg. and passed through the automatic welder again for welding the other links.—*September* 17, 1952.

MARINE ENGINEERING

679,593. December 29, 1950.—SHIPS' SCREW PROPELLERS, Maximiliaan Maria Hendricus Lips, Drunen, The Netherlands.

The invention aims at making propellers with the same thickness at the foot as is usual, but of lighter weight. The drawing shows, in side elevation, a four-bladed screw propeller. Assuming that the magnitude and distribution of the propulsive, tangential, centrifugal and frictional forces, acting on a blade of the propeller are known, or can at least be approximately estimated, it is possible to determine the stresses, especially the bending stresses, which



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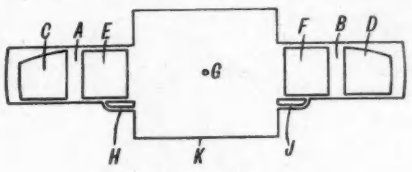
these forces set up at the root *A* of the upper blade *B* when the root is of given dimensions such as thickness *C* at the place of the chosen section of the blade. In the drawing, the graph of moments *D* is given, and the forces set up a maximum bending stress of σ_v. The maximum strength of the material of which the blade is made is also known at the same place. It is the maximum bending stress σ_{max} which the material can withstand without giving way. The difference between σ_{max} and σ_v is thus a "stress reserve," referred to as $\sigma_{v\,res}$, an additional stress which the blade can absorb, when any unexpected force in general acts upon it. At a section *E* of the blade the calculable forces also cause it to bend, while at a given thickness *C* they also produce a graph of moments *F* with a bending stress σ. The thickness *C* is so calculated that an additional force *G* acting on the top of the blade, which sets up the stress $\sigma_{v\,max}$ at the foot *A*, will also set up a stress at the section *E*, in such a manner that there too the same force *G* will give rise to a stress σ_{max} of the material. When the propeller is operating a force *G* as indicated will give rise to the stress σ_{max} along the whole length *L* of the blade. There is therefore, no "most favourable" section, and the blade will tend to bend along its whole length. The blade will thus be considerably lighter and consequently thinner than the conventional blade at a section *E*. At this section the force *G* will naturally set up a moment which is a fraction *L*/*M* of the moment the force *G* sets up at the root *A* of the blade. This is the moment that has to produce σ_{res} in that place.—*September* 17, 1952.

REFRIGERATING MACHINERY

680,421. January 31, 1947.—REFRIGERATING SYSTEMS, N.V. Philips' Gloeilampenfabrieken, Emmasingel, Eindhoven, The Netherlands.

According to the invention, a refrigerating system comprises a hot gas reciprocating engine driving a refrigerating apparatus and operating according to the reversed hot gas engine principle. Means are provided to connect momentarily at a desired point in the cycle either the working space of the hot gas engine or the working space of the refrigerating apparatus to a common space, from which the same working medium is obtained for both the engine and the apparatus. These



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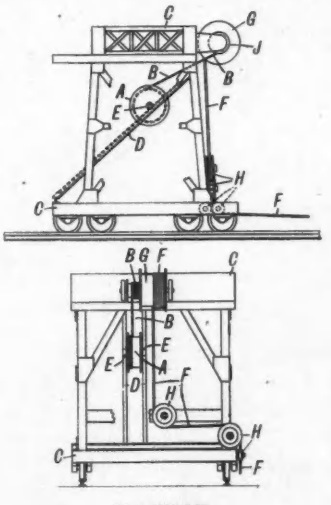
spaces can be separated or connected with the open air. In the drawing the hot gas reciprocating engine is denoted by *A* and the refrigerating engine by *B*. The hot gas engine and the refrigerating engine each comprise a cylinder in which a displacer piston *C* and *D* respectively and a main piston *E* and *F* respectively are connected through a rod system to a crankshaft *G*. Ducts *H* and *J* respectively are provided in such way that the working space of the hot gas engine and of the refrigerating engine can communicate periodically and momentarily with the space within the crank case *K* to replenish losses due to leaks. Air may be drawn into the crank case through an air filter communicating with the atmosphere.—*October* 8, 1952.

CRANES AND LIFTING APPLIANCES

680,840. June 6, 1950.—SUPPLYING ELECTRIC OR FLUID POWER TO A POWER-DRIVEN RECIPROCATING CARRIAGE, David Rushworth, 40, Dovedale Road, West Bridgford, Nottingham.

The drawings show elevations of a carriage illustrating one method according to the invention of paying out and taking up an electric supply cable or a hose connected between a reciprocating carriage



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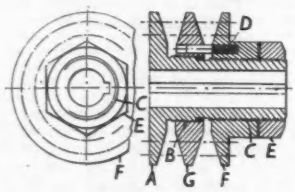
and a fixed supply point. The take-up drum *A*, having a rope *B* wound on it, is mounted on an inclined track on the reciprocating carriage *C* so that it will rotate as it moves up and down the track. For this purpose the track may comprise two inclined toothed racks *D* and the take-up drum is mounted on an axle having toothed pinions to engage with the racks so that as the drum moves upwards or downwards the pinions roll on the racks and rotate the take-up drum.

In the arrangement shown, the power supply cable *F* is wound on a reel *G* and extends from it over suitable guide pulleys *H* on the carriage *C* to a fixed power supply point. As the carriage moves away from the power supply point the cable or hose will be drawn off the reel *G*. At the side of the reel is a second drum *J* of smaller diameter, and the rope from the take-up drum is wound round this second drum in the opposite direction to that in which the cable is wound on the reel *G*. It will be seen that when the cable *F* or hose is drawn off the reel *G* the second drum *J* will wind up the rope *B*, and as a result it will be withdrawn from the take-up drum, which will be rotated and roll up the inclined toothed racks. When the carriage moves towards the power supply point the reverse action will take place. By making the take-up drum *A* large in diameter in relation to the diameter of the second drum *J* the cable reel can be made so that it will accommodate an appreciable length of cable or hose whilst keeping the inclined track within a reasonable length. Alternative constructions are also shown in the specification.—*October* 15, 1952.

POWER TRANSMISSION

681,123. October 24, 1950.—GROOVED PULLEYS, Pierre Thonnard, Torno (Como), Italy, and John Hassard Hassard Thompson, 29, Via Diaz, Como, Italy. (*Inventors: Giovanni Salvatico and Ermete Greco.*)

In the drawing, *A* is a fixed flange, with a hub projecting on one side only, and having a thread *B* and successive thread *C* near the hub end. The pitch of the thread *C* is twice that of *B*. A pin *D* is screwed



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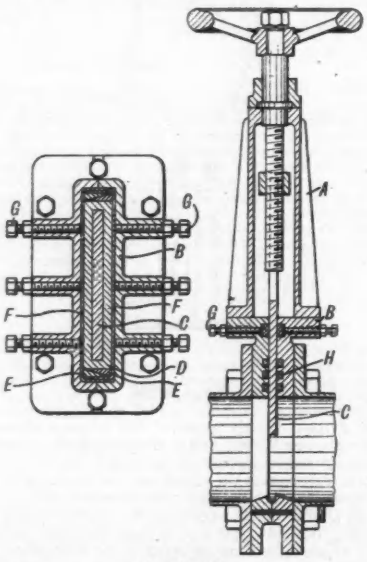
on the flange and slides in a corresponding hole er flange. A nut *E* screwed on the thread *C* acts as a lock-nut. When the average diameter of the conical surfaces on which the "V"-belts work is to be increased, the lock-nut is loosened and the flange *F* rotated by a spanner. Due to the ratio of the pitch of the thread *B* to that of thread *C*, the flange *G* is displaced axially by an amount double that of the flange *F*, the flanges thereby being brought to engage the belts in the new position.—*October* 15, 1952.

VALVES

681,085. July 18, 1951.—SLUICE VALVES, Allan Grannenfelt, 41, Boktryckarvagen, Hagersten, near Stockholm, Sweden.

This invention relates to a sluice valve, especially adapted to be used in pulp lines. The wear is considerable when fibre suspensions are pumped through such valves, and the invention facilitates the replacement of packings. The valve case consists of three parts, an upper hollow part *A* supporting the valve spindle, and two lower parts *B* forming the sides of the case, to be mounted in a pipe-line. The drawing shows the general construction of the valve. In order



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to provide a safe sealing between the plate *C* and the valve case, a packing according to the invention is placed in recesses just below the upper ends of the two case members *B*, shown in the left hand view. A packing ring *D* of hemp and tallow, surrounds the plate. Two wedges *E*, having their sloping surfaces contacting each other, are placed outside the packing at each edge of the plate. The packing and the wedges are encased between two lids or strips *F*, which overlap each other somewhat at the edges of the plate. Set screws *G* are inserted through the case members to engage the outer sides of the lids *F*. When these screws are tightened, the packing is pressed on to both sides of the plate, and at the same time the wedges, at the edges of the plate, slide across each other with their sloping surfaces, so that the packing material *D* is pressed also against the edges of the plate *C*. Further sealing of the plate is provided by three curved packings *H* made of some lubricating material, and placed in corresponding recesses in the case members. These packings also serve to keep the plate free from impurities, such as fibres, &c.—*October* 15, 1952.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Mon., Nov. 3rd.—LEEDS BRANCH: Great Northern Hotel, Leeds, "Television," H. B. Reeder, 7.30 p.m.——N.E. LONDON BRANCH: Angel Hotel, Ilford, "Motor Repairs," D. R. Reekie, 8 p.m.

Tues., Nov. 4th.—NOTTINGHAM BRANCH: E. Midlands Electricity Board, Smithy Row, Nottingham, "Modern Developments of Variable Speed Electric Drives," J. V. Woods, 7.30 p.m.——W. LONDON BRANCH: Windsor Castle Hotel, 134, King Street, Hammersmith, W.6, "The Use of Electricity in the Gas Industry," Owen H. Baker, 7.30 p.m.

Wed., Nov. 5th.—N. LONDON BRANCH: Three Jolly Butchers Hotel, Wood Green, N.22, "Tape Recorders," W. H. Y. Grainger, 8.15 p.m.

Thurs., Nov. 6th.—S. LONDON BRANCH: Cafe Royal, North End, Croydon, "Radar Aids to Marine Navigation," E. Fenessey, 8 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Nov. 5th.—LONDON SECTION: London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, "The Specification and Design of Standardised Units for Electronic Computers," A. D. Booth, 6.30 p.m.

Thurs., Nov. 6th.—SCOTTISH SECTION: Engineering Centre, Sauchiehall Street, Glasgow, "The Development of the Radio and Electronics Industry in India," G. D. Clifford, 7 p.m.

ELECTRIC RAILWAY SOCIETY

Thurs., Nov. 6th.—Fred Taliant Hall, 153, Drummond Street, London, N.W.1, "Melbourne's Electric Railway," C. L. Busch, 7.15 p.m.

HULL CHEMICAL AND ENGINEERING SOCIETY

Tues., Nov. 4th.—Church Institute, Albion Street, Hull, "Personnel Selection," B. Ungerson, 7.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

To-day, Oct. 31st.—BIRMINGHAM CENTRE: Regent House, St. Philip's Place, Colmore Row, Birmingham, "The Evaluation of Lighting," R. G. Hopkinson, 6 p.m.

Tues., Nov. 4th.—STOKE-ON-TRENT GROUP: Midlands Electricity Board, 31, Kingsway, Stoke-on-Trent, "Planning an Industrial Lighting Scheme," V. A. Heydon, 6 p.m.

Wed., Nov. 5th.—EDINBURGH CENTRE: Lighting and Cleansing Department, 357, High Street, Edinburgh, "On Planning Lighting Installations," J. F. Roper, 7 p.m.——NEWCASTLE CENTRE: Minor Durrant Hall, Oxford Street, Newcastle upon Tyne, "The Architect's Approach to Artificial Lighting," R. G. Cox, 6.15 p.m.

Thurs., Nov. 6th.—GLASGOW CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, "The Lighting of Shipyards," J. S. McCulloch, 6.30 p.m.——NOTTINGHAM CENTRE: E. Midlands Electricity Board, Smithy Row, Nottingham, "The Effect of Light in the Growth and Development of Plants," Miss D. Vince, 6 p.m.——BRADFORD GROUP: Yorkshire Electricity Board, 45–53, Sunbridge Road, Bradford, "Glass and its Manufacture," F. Mathers, 7.30 p.m.

Fri., Nov. 7th.—HUDDERSFIELD GROUP: Electricity Showroom, Market Street, Huddersfield, "Modern Aerodrome Lighting," J. W. Morse, 7.15 p.m.

INCORPORATED PLANT ENGINEERS

To-day, Oct. 31st.—BIRMINGHAM BRANCH: Imperial Hotel, Birmingham, "The Tacoma Bridge Failure," 7.30 p.m.

Tues., Nov. 4th.—LONDON BRANCH: Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "Maintenance of Aircraft," R. A. Tidd, 7 p.m.——S. WALES BRANCH: S. Wales Institute of Engineers, Park Place, Cardiff, "Chrome and Nickel Plating Processes," 7.15 p.m.

Wed., Nov. 5th.—SOUTHAMPTON BRANCH: Polygon Hotel, Southampton, "Steam Utilisation," J. C. Chynoweth, 7.30 p.m.

Thurs., Nov. 6th.—PETERBOROUGH BRANCH: Eastern Gas Board's Demonstration Theatre, Church Street, Peterborough, "Anti-Corrosives," L. Evans, 7.30 p.m.

INSTITUTE OF ECONOMIC ENGINEERING

Sat., Nov. 1st.—The Christian Institute, 70, Bothwell Street, Glasgow, "Time Study," J. Jones, 10.30 a.m.

INSTITUTE OF MARINE ENGINEERS

Wed., Nov. 5th.—JUNIOR LECTURE: Technical College, East Ham, "Construction of Marine Boilers," A. P. Monk, 7.15 p.m.

Thurs., Nov. 6th.—JUNIOR LECTURE: City and Guilds College, South Kensington, London, S.W.7, "Construction of Marine Boilers," A. P. Monk, 5.30 p.m.

INSTITUTE OF METALS

To-day, Oct. 31st.—BIRMINGHAM LOCAL SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, Discussion on "Aluminium *v.* Steel as Structural Material," 6.30 p.m.

Tues., Nov. 4th.—OXFORD LOCAL SECTION: Black Hall, St. Giles, Oxford, "The Pressing and Sintering of Metal Powders," J. C. Chaston, 7 p.m.——S. WALES LOCAL SECTION: Metallurgy Department, University College, Singleton Park, Swansea, "The Rogerstone Strip Mill," F. King, 6.30 p.m.

Thurs., Nov. 6th.—BIRMINGHAM LOCAL SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Metallurgical Problems Imposed by Stratospheric Flight," P. L. Teed, 6.30 p.m.——LONDON LOCAL SECTION: Royal School of Mines, South Kensington, London, S.W.7, "An Approach to the Theory of Ternary Alloys," G. V. Raynor, 7 p.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

Mon., Nov. 3rd.—SCOTTISH CENTRE: North British Hotel, Edinburgh, "Trends of Vehicle Design as Indicated by the Commercial Motor Show, 1952," L. J. Cotton, 7.30 p.m.

Tues., Nov. 4th.—EASTERN CENTRE: Bird in Hand Hotel, Peterborough, "Various Trends in Machining and Inspection Methods Concerning the Manufacture of Heavy Commercial Vehicles," E. I. Perry, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

To-day, Oct. 31st.—YORKSHIRE ASSOCIATION: Great Northern Station Hotel, Leeds, "The Tinsley Sewerage Scheme, Sheffield," N. A. Pritchard, 7 p.m.

Tues., Nov. 4th.—Great George Street, London, S.W.1, Presidential Address, H. F. Cronin, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Nov. 3rd.—LONDON STUDENTS' SECTION: Savoy Place, London, W.C.2, "Lightning," J. H. Gridley, 7 p.m.——S. MIDLAND CENTRE: James Watt Memorial Institute, Great Charles Street, Birmingham, "275kV Developments on the British Grid System," D. P. Sayers, F. J. Lane and J. S. Forrest, 6 p.m.

Tues., Nov. 4th.—MEASUREMENTS SECTION: Savoy Place, London, W.C.2, Discussion on "Circuit Applications of Cold-Cathode Trigger Tubes," opened by K. Kandiah, 5.30 p.m.

Wed., Nov. 5th.—TEES-SIDE SUB-CENTRE: Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, "Electricity in Farm Crop Drying," C. A. Cameron Brown and P. G. Finn-Kelcey, 6.30 p.m.——SOUTHERN CENTRE: The University, Southampton, "Equipment of Battery Electric Vehicles," W. J. Sheers, "The Economic Basis of Battery Electric Road Vehicle Operation and Manufacture," H. W. Heyman, 6.30 p.m.

Thurs., Nov. 6th.—ORDINARY MEETING: Savoy Place, London, W.C.2, "Telemetering for System Operation," R. H. Dunn and C. H. Chambers, 5.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Thurs., Nov. 6th.—Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, "The Manufacture and Inspection of Paper," G. Thompson, 6 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Nov. 4th.—39, Elmbank Crescent, Glasgow, "The Plant Engineer in Industry," A. J. MacIntyre, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Oct. 31st.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, "Machine Tool Simplification, Especially as Applied to Horizontal Boring Machines," C. A. Sparkes, 5.30 p.m.

Tues., Nov. 4th.—AUTOMOBILE DIVISION: Storey's Gate, St. James's Park, London, S.W.1, James Clayton Lecture, "Automatic Transmissions in America," Charles A Chayne, 5.30 p.m.

Fri., Nov. 7th.—GENERAL MEETING: Storey's Gate, St. James's Park, London, S.W.1, Discussion on "Water Turbine Governors," N. G. Dennis, 5.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Tues., Nov. 4th.—JOINT MEETING, HALIFAX, YORKSHIRE AND SHEFFIELD SECTIONS: George Hotel, Huddersfield, "The Development of Engineering Metrology," F. H. Rolt, 7.15 p.m.

Thurs., Nov. 6th.—LEICESTER SECTION: Bell Hotel, Leicester, "Choice of Turning Equipment," R. C. Fenton, 7 p.m.——LONDON SECTION: Power Samas Accounting Machines, Ltd., Aurelia Road, Mitcham Road, Croydon, "Figures as an Aid to Production Engineers," T. Whitwell, 7 p.m.——READING SECTION: Great Western Hotel, Reading, "Modern Developments in Heat Treatment Practice," K. J. B. Wolfe, 7.15 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Nov. 3rd.—Neville Hall, The Mining Institute, Newcastle, "Processes and Materials for Rubber Cables," B. B. Evans, 7 p.m.

INSTITUTION OF SANITARY ENGINEERS

Tues., Nov. 4th.—Public Works Congress, Olympia, London, "Rural Water Supplies and Sewerage from the County Viewpoint," F. M. W. King, 3 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Tues., Nov. 4th.—NORTHERN COUNTIES BRANCH: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Unusual Design for a Large Constructional Shop," F. R. Bullen, 6.30 p.m.——NORTHERN IRELAND BRANCH: College of Technology, Belfast, "Theory and Practice of Prestressed Concrete," Stanley Marchant, 6.45 p.m.

Fri., Nov. 7th.—WESTERN COUNTIES BRANCH: The University, Bristol, "The Design and Construction of Reinforced Concrete Silos and Bunkers," G. P. Bridges, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Oct. 31st.—INFORMAL MEETING: Townsend House, Greycoat Place, London, S.W.1, "Some Problems in the Design of Motion Picture Sound Equipment," W. C. C. Ball, 7 p.m.

Wed., Nov. 5th.—MIDLAND SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Oil Fired All Basic Furnaces," James Mitton, 7 p.m.

Fri., Nov. 7th.—FILM EVENING: Townsend House, Greycoat Place, London, S.W.1, "New Esso Refinery," Part I and II introduced by C. W. Odell, 7 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

To-day, Oct. 31st.—Literary and Philosophical Society, Newcastle upon Tyne, Parsons Memorial Lecture, "From Stodola to Modern Turbine Engineering," Claude Seippel, 6.15 p.m.

PUBLIC WORKS AND MUNICIPAL SERVICES CONGRESS AND EXHIBITION

Mon., to Sat., Nov. 3rd. to 8th.—Olympia, London.

ROYAL AERONAUTICAL SOCIETY

Tues., Nov. 4th.—GRADUATES' AND STUDENTS' SECTION: 4, Hamilton Place, London, W.1, "Liquid Fuel Rocket Motors," B. R. Diplock, D. L. Lofts and R. A. Grimston, 7.30 p.m.

SHEET AND STRIP METAL USERS TECHNICAL ASSOCIATION

Wed. to Fri., Nov. 5th to 7th.—Grand Hotel, Birmingham, Annual General Meeting and Autumn Conference.

SHEFFIELD METALLURGICAL ASSOCIATION

Tues., Nov. 4th.—Grand Hotel, Sheffield, "Steel Castings for the Chemical Industry," R. W. Stobbs, 7 p.m.